CROPS & SOILS RESEARCH 1968

DEPARTMENT OF AGRONOMY
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MARYLAND

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Progress Research Report
Vol. 2, August 1969

1995327

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INTRODUCTION

Research Program in Department of Agronomy

This report gives the research in progress in the Department of Agronomy. The purpose of the research program in the Department is to develop improved crop varieties and improved soil and crop management practices that result in more efficient crop production. Of equal importance is the development and application of principles of soil and water use and conservation. Investigations of the fundamental principles of genetics, physiology and biochemistry of crops and the nature and properties of soils are major objectives of the Department of Agronomy. Results from the basic research are applied to the practical problems of agronomic nature.

The wide range of soils and 2.3 million acres of agronomic crops (corn, soybeans, tobacco, small grain, turfgrasses, hay, and pasture) grown in the state with a value of approximately 150 million dollars emphasize the size and importance of the research program in agronomy. To solve crops and soils problems research work is conducted at the University, on the University farms, and with cooperating farmers, golf course superintendents, and others throughout the state.

James R. Miller

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Director, Maryland Agric. Expt. Sta.

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Development of Improved Strains of Maryland Tobacco Resistant to Disease

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

A number of diseases attack tobacco grown in Southern Maryland; therefore, a large part of the breeding program at the University of Maryland is concerned with disease resistance. At the present time the tobacco mosaic virus appears to be the most destructive disease and until recently, none of the varieties being grown had mosaic resistance. Other diseases which cause some loss in Maryland tobacco each year are black root rot (Thielaviopsis basicola), wildfire (Pseudomonas tabaci), black shank (Phytophthora parasitica var. nicotianae), and fusarium wilt (Fusarium oxysporum var. nicotianae). At present the tobacco breeding program is concerned with developing varieties with resistance to two diseases -- tobacco mosaic and black shank.

Procedures

Breeding for Black Shank Resistance. The source of resistance to black shank presently being used is from Md. 59 and Md. 609 which are two varieties released in 1965. These two varieties were developed by Dr. O. D. Morgan, and the source of black shank resistance was from Florida 301.

During March and April, 1968 a modification of a black shank screening procedure utilized at the University of Kentucky was used to screen approximately 50 entries in the F_2, F_3, F_4, and F_5 generations. The procedure involved planting approximately 10 to 15 seeds of an entry in a vermiculite-filled, 50-ml polypropylene centrifuge tube. About 4 weeks after seeding the seedlings were inoculated with the black shank fungus. Two weeks after inoculation the entries were scored on above ground plant parts (leaves and stems) and the roots. A scoring system of 0, 1, 2, 3, and 4 was utilized

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for the leaves and stems with a score of 0 representing no symptoms of the disease and a score of 4 representing complete death of all seedlings. A similar system was used for the roots symptoms with 0 representing no symptoms (roots white) and 4 representing severe browning of the entire root system.

Breeding for Mosaic Resistance. During January, 1968, 54 entries in the F_2, F_3, F_4, and F_5 generations were screened for mosaic resistance. Each entry was represented by 10 plants. Seedlings which were approximately 2 months old were inoculated with the tobacco mosaic virus by rubbing the leaf with cheesecloth saturated in a solution of the virus. Approximately one week after inoculation, readings were made on the number of resistant and susceptible plants in each entry. At the time of scoring the resistant plants exhibited small necrotic spots at the cite of inoculation while the susceptible plants exhibited the characteristic mosaic pattern of dark and light green areas in the new growth. The necrotic spots of the resistant plants are due to a hypersensitive reaction of the leaf tissue to the virus. When the virus contacts the leaf cells, the cells die at such a rapid rate that the virus cannot spread.

Results

Black Shank Resistance. The results of the screening procedure for black shank resistance are presented in Figure 1. Considerable variation was found among the entries for black shank resistance. Some entries appeared to have complete resistance while others were completely susceptible. For the leaf and stem score, 57.1% of the entries received a score of 1.5 or better while 44.9% of the root scores fell within this same range. Entries with a score of 1.5 would probably have adequate resistance under field conditions in southern Maryland.

One reason for the wide variation among the entries for black shank resistance could be due to the nature of inheritance of the resistance. Resistance is believed to be dependent upon two major genes and several modifiers; therefore, through breeding the ultimate objective is to capture the two major genes and accumulate as many of the modifiers as possible.

Mosaic Resistance. The results of the tobacco mosaic screening procedure are shown in Figure 2. Approximately 57.4% of the entries showed good resistance with all 10 plants within each entry being resistant. A small percentage of the entries had one, two, three, or four plants out of 10 susceptible while 16.7% of the entries were completely susceptible (0:10 ratio). Resistance is determined by a single dominant gene; therefore, the plants fell into one of two classes -- resistant or susceptible. From the data in Figure 2 it appears that approximately 57% of the entries were homozygous for resistance and approximately 26.0% of the entries were still segregating (entries with ratios of 9:1, 8:2, 7:3, and 6:4).

Summary

Breeding lines with resistance to black shank and tobacco mosaic are being developed. Screening techniques which are relatively simple and reliable are being used in the greenhouse. Lines with good resistance based on greenhouse results were advanced an additional generation in the field nursery during the summer. Selection for plant type and other desirable agronomic traits was done in the field nursery.

Some of the breeding lines which have good resistance and desirable plant types are now being prepared for some preliminary field trials under replicated conditions.

Recently a new Catterton type breeding line was released as Md. 10. This was a joint release by the Maryland Agricultural Experiment Station and the USDA, and is the first Maryland variety with mosaic resistance.

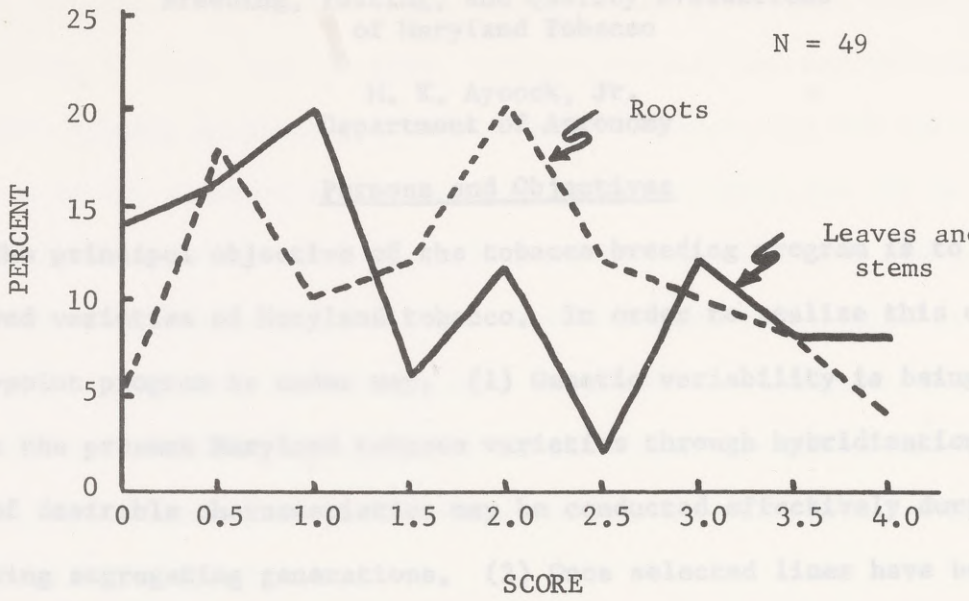

Figure 1. Frequency distribution of entries screened for black shank resistance; 0 = completely resistant and 4 = dead. (1968)

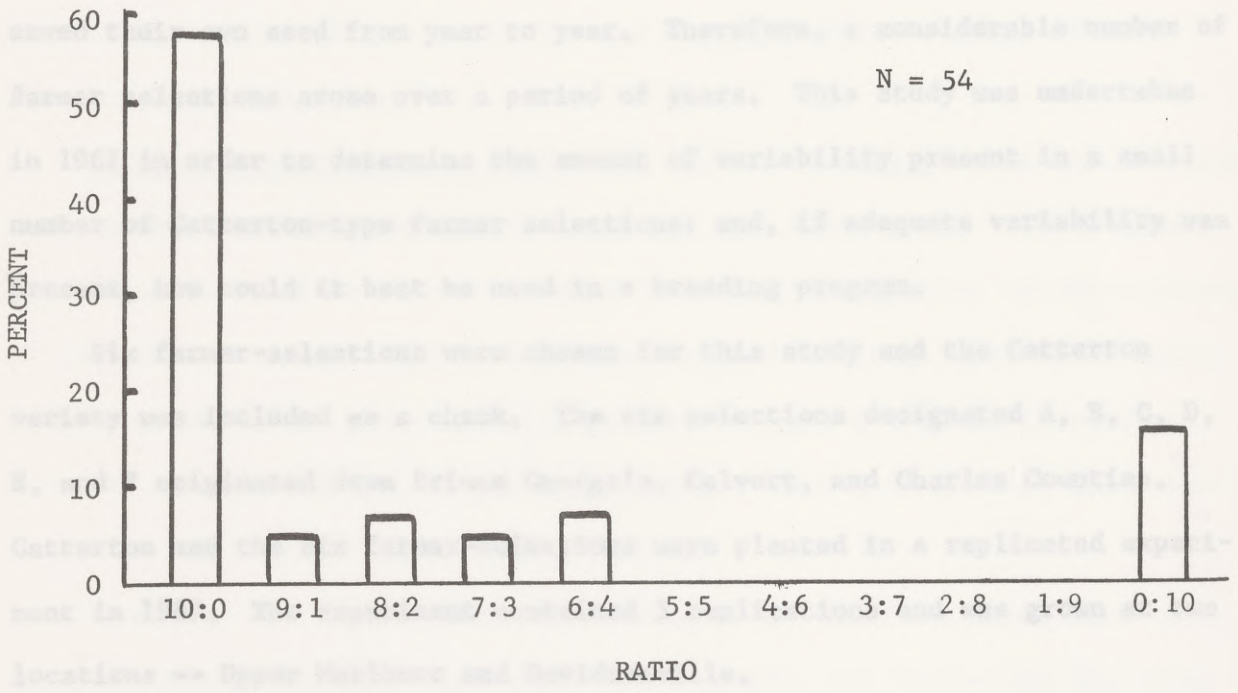

Figure 2. Frequency distribution of entries screened for tobacco mosaic resistance. The ratio is expressed as the number of resistant plants to the number of susceptible plants. (1968)

Breeding, Testing, and Quality Evaluations of Maryland Tobacco

M. K. Aycock, Jr.
Department of Agronomy

Purpose and Objectives

The principal objective of the tobacco breeding program is to develop improved varieties of Maryland tobacco. In order to realize this objective, a two-point program is under way. (1) Genetic variability is being created within the present Maryland tobacco varieties through hybridization so selection of desirable characteristics may be conducted effectively during the following segregating generations. (2) Once selected lines have been obtained, they are evaluated in field experiments for several years at various locations in southern Maryland.

Procedures

Catterton Types. For many years, tobacco farmers in southern Maryland saved their own seed from year to year. Therefore, a considerable number of farmer selections arose over a period of years. This study was undertaken in 1967 in order to determine the amount of variability present in a small number of Catterton-type farmer selections; and, if adequate variability was present, how could it best be used in a breeding program.

Six farmer-selections were chosen for this study and the Catterton variety was included as a check. The six selections designated A, B, C, D, E, and F originated from Prince George's, Calvert, and Charles Counties. Catterton and the six farmer-selections were planted in a replicated experiment in 1967. The experiment contained 3 replications and was grown at two locations -- Upper Marlboro and Davidsonville.

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H. K. Ayscue, Jr.
Department of Agronomy

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F_1 Hybrids. F_1 hybrids are presently being grown on a commercial scale in a number of crops such as corn, sorghum, onions, and burley tobacco. Success with hybrids in these crops is possible because, (1) the hybrid is superior to the standard variety in one or more traits, and (2) an economical method of seed production is available. With the successful production of burley hybrids, considerable interest has developed in Maryland as to the potential of hybrids. Therefore, this study was undertaken in 1967 by C. J. Fan to determine the amount of hybrid vigor present in Maryland tobacco hybrids, and to gain some understanding of the genetic variances present in Maryland tobacco populations.

In 1967 five varieties and 10 F_1 hybrids (all possible hybrid combinations of the five varieties excluding reciprocals) were grown in a field study at Upper Marlboro and Davidsonville. A split-plot design was utilized with three replications at each location. A family was considered the whole-plot and it contained one hybrid and its two parents for a total of three sub-plots per whole-plot.

Official Variety Tests - 1967. The variety testing program is the final phase of the breeding program and has three main objectives: (1) To obtain additional information on the varieties presently being grown by the majority of the tobacco farmers, (2) to evaluate advanced breeding lines which appear to have potential as a new variety, and (3) to provide a guide to southern Maryland tobacco farmers for use in choosing a variety to produce their best crop.

Each year the variety tests are conducted at three locations with varying soil types. At Upper Marlboro, Davidsonville, and Dentsville the tests are grown on Monmouth fine sandy loam, Galestown loamy sand, and Beltsville silt loam soils, respectively.

The 1967 test, which is included in the present report, contained eight varieties and eight breeding lines. The eight breeding lines in the test were developed by the USDA at Beltsville under the direction of H. A. Skoog.

Four replications of a randomized complete block design were used at each location. Each plot consisted of one row of 28 competitive plants. The plots were three feet apart and plants spaced two feet apart in the plot. Twenty-five competitive plants per plot were cut at harvest.

The various agronomic and chemical characteristics measured and methods of data collection have been outlined by Aycock et al., 1968, Md. Agr. Exp. Sta. Mis. Pub. 662.

Results

Catterton Types. Agronomic and chemical data for the six Catterton-type farmer selections and standard Catterton are presented in Table 1. These data are the average of two locations. In general the performance of the farmer selections was quite similar when compared among the selections or with Catterton. Significant differences among the seven entries were noted for only two traits -- plant height and internode length.

Differences between the two locations were noted for a number of traits (Table 1). Similar location differences have been found in other studies (Aycock et al., 1968, Md. Agr. Exp. Sta. Mis. Pub. 662). Such differences could be expected, however, since soil and climatic conditions are quite different for the two locations.

In general, essentially no useable variation existed among the six farmer selections tested. Also no selection appeared superior to Catterton particularly for quality as measured by price per pound. Therefore from these results, it appears that genetic variation must be obtained from some other source.

F_1 Hybrids. The results completed to date are shown in Table 2 by locations. The hybrids yielded more cured leaf per acre than the parents (varieties) at Upper Marlboro. At both locations the hybrids had a higher value per acre and value per hundredweight and were earlier flowering than the parents. No differences were noted for total alkaloids and nitrogen.

Official Variety Tests - 1967. The results obtained on the varieties and breeding lines for 1967 are shown in Table 3. The top yielding varieties were Wilson and Md. 64 with 1991 and 1945 pounds per acre, respectively. J-66-125F-2 a Wilson breeding line with mosaic, wildfire and fusarium wilt resistance was the highest yielder of all varieties and breeding lines with 2007 pounds per acre of cured leaf. The best quality tobacco, as measured by dollars per hundredweight, was produced by Md. 609. In general the high yielding lines tended to be lower in quality than the test average.

Agronomically, differences were noted among the entries for most characters studied. Maturity as measured by the number of days from transplanting to flowering varied from 54.4 days for J-66-219F-1 to 58.4 days for Md. 10.

Considerable variation was noted in total alkaloids and total nitrogen; however, all entries were well within the range of acceptability.

All of the breeding lines in the test have resistance to the tobacco mosaic virus and fusarium wilt. In addition certain lines have resistance to black root rot and wildfire. The tobacco mosaic virus causes the greatest loss each year, and just recently Md. 10 was released which contains resistance to this pathogen. Md. 10 is a Catterton type and very similar to standard Catterton in all characters measured. Most of the standard varieties have a good level of tolerance to black root rot and fusarium wilt. In addition Md. 59 and Md. 609 have resistance to black shank.

Summary

Two methods have been utilized in the tobacco breeding program in order to obtain genetic variability. Firstly, a selected number of Catterton-type farmer selections was compared with standard Catterton, and secondly, the five most popular varieties were crossed in all possible combinations excluding reciprocals in order to create several segregating generations. To date the second method appears to be the most productive.

The variety testing program was conducted at three locations in 1967. Several breeding lines with multiple disease resistance appear to have real potential as new varieties. Evidence of this is the recent release of Md. 10, a mosaic resistant Catterton-type variety.

Table 1. Performance of Catterton-type tobacco lines grown at two locations, 1967.

Entry	Yield per acre (lbs.)	Value ¢/lb.	Value $/A	Plant height (cm)	Leaves per plant	Internode length (cm)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
A	1601	72.2	1157	86.0	20.9	4.1	51.8	2.18	1.99	5.6	6.47
B	1498	71.0	1066	88.0	21.2	4.2	53.7	2.20	2.25	6.0	6.75
C	1549	72.1	1118	78.7	19.6	4.0	51.1	2.30	2.31	8.2	6.77
D	1552	72.2	1121	82.8	20.3	4.0	51.6	2.13	2.25	6.3	6.62
E	1504	72.0	1083	74.1	20.4	3.6	53.0	2.48	2.24	7.4	6.38
F	1496	71.9	1076	79.3	19.4	4.1	51.8	2.14	2.25	6.5	6.65
Catterton	1535	73.0	1121	80.4	20.1	4.0	50.4	2.46	2.26	7.3	6.82
Mean	1534	72.0	1106	81.3	20.3	4.0	51.9	2.27	2.22	6.8	6.64
L.S.D. (5%)	NS	NS	NS	6.2	NS	0.3	NS	NS	NS	NS	NS
C.V. (%)	5.5	1.9	6.5	6.2	4.8	4.2	2.0	12.8	10.7	28.1	4.4
Marlboro (M)	1501	70.0	1052	85.8	21.0	4.1	51.6	2.36	2.34	3.8	6.70
Davidsonville (D)	1566	74.1	1161	76.9	19.5	3.9	52.2	2.11	2.11	9.7	6.58
M vs. D	*	**	**	**	**	NS	NS	NS	*	**	NS

* Significant at the 5% level.

** Significant at the 1% level.

Table 2. Performance of five varieties and 10 F_1 hybrids of Maryland tobacco grown at two locations, 1967.

Parent or F_1 hybrid	Yield per acre (lbs.)	Value $/A	Value $/cwt.	Days to flower	Total alkaloids (%)	Total nitrogen (%)
		Upper Marlboro				
Parental mean	1435	920	64.14	47.5	2.16	2.45
F_1 hybrid	1504	1011	67.13	46.6	2.15	2.36
Parents vs. F_1's	*	**	**	**	NS	NS
		Davidsonville				
Parental mean	1792	1195	66.86	51.9	2.03	2.22
F_1 hybrid mean	1844	1284	69.89	51.0	2.07	2.23
Parents vs. F_1's	NS	**	**	**	NS	NS

NS = Non-significant.

* Significant at the 5% level.

** Significant at the 1% level.

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F_1 hybrid	1504	1011	67.13	46.6	2.15	2.36
Parents vs. F_1's	*	**	**	**	NS	NS
Davidsonville						
Parental mean	1792	1195	66.86	51.9	2.03	2.22
F_1 hybrid mean	1844	1284	69.89	51.9	2.07	2.23
Parents vs. F_1's	NS	**	**	**	NS	NS

NS = Non-significant.

* Significant at the 5% level.

** Significant at the 1% level.

Table 3. Performance of Maryland tobacco varieties and breeding lines at three locations, 1967.

Variety or breeding line	Yield lbs/A	Value $/A	Value $/cwt.	Plant height (in.)	Leaves per plant	Internode length (in.)	Days to flower	Total alkaloids (%)	Total nitrogen (%)	Duration of burn (sec.)	Filling capacity (cc/g)
Catterton	1745	1110	63.57	33.1	19.7	1.7	56.3	2.46	2.59	7.0	6.65
Wilson	1991	1224	61.46	29.4	19.8	1.5	55.6	2.37	2.69	6.5	6.42
Moore	1739	1021	58.76	30.6	20.2	1.5	56.8	2.96	2.45	4.9	6.64
Gertz	1765	1145	64.90	30.6	19.2	1.6	54.0	3.52	2.13	5.3	5.97
Md. 59	1629	1098	67.27	32.5	18.8	1.7	55.6	2.78	2.60	8.7	6.18
Md. 609	1744	1218	69.67	33.2	19.2	1.7	57.2	2.53	2.90	7.5	6.15
Md. 64	1945	1184	60.42	29.3	21.0	1.4	58.2	2.44	2.51	8.0	6.53
Md. 10	1789	1130	63.22	34.2	20.2	1.7	58.4	2.47	2.62	11.5	6.52
J-66-4F-2	1749	1121	63.94	34.8	20.3	1.7	58.3	2.37	2.46	9.0	6.68
J-66-6F-3	1797	1116	62.04	33.5	20.2	1.6	56.5	2.61	2.60	6.2	6.51
J-66-20F-1	1810	1141	62.96	34.7	19.7	1.8	57.2	2.44	2.28	7.1	6.88
J-66-45F-3	1731	1140	65.70	31.5	19.0	1.6	56.0	3.56	2.80	4.6	6.07
J-66-113F-1	1937	1142	58.77	31.4	19.3	1.6	55.7	2.45	2.47	8.4	6.28
J-66-125F-2	2007	1189	59.03	31.8	19.3	1.6	58.3	2.43	2.77	5.2	6.45
J-66-127F-1	1814	1024	56.06	29.8	17.9	1.6	56.3	2.52	2.73	6.8	6.02
J-66-219F-1	1806	1177	65.09	34.1	18.6	1.8	54.4	2.43	2.44	10.3	6.38
Mean	1812	1136	62.68	32.2	19.5	1.6	56.6	2.65	2.56	7.3	6.40
L.S.D. (.05)	142	N.S.	4.23	2.5	1.1	0.10	2.0	0.35	0.39	N.S.	0.46
(.01)	191	N.S.	5.70	3.3	1.5	0.13	2.7	0.47	N.S.	N.S.	N.S.
C.V. (%)	9	10	5	5	5	4	2	13	15	47	6

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The Response of Corn and Alfalfa to Fertility and Irrigation

N. A. Clark
Department of Agronomy

Purpose and Objectives

This study compares corn and alfalfa under three fertility levels, and with overhead irrigation, subirrigation, and no irrigation. Most irrigation systems in use on farms in the Northeast are the overhead type. Subirrigation, using plastic pipe is a recent development that has been tested in the Northeast[1], but has not been compared directly with overhead irrigation. An objective of this study was to make such a direct comparison. It was postulated that the two systems might differ in water use due to differences in evaporation and movement into the subsoil under the two systems.

Procedure

The experiment was a split plot design with irrigation regimes as whole plots. Crops and fertility treatments were assigned at random as sub plots within each whole plot. There were three replications. The crops were: alfalfa, corn silage, corn grain, double crop corn silage - small grain silage. Fertilizer treatments were: 1/2 soil test recommendation, soil test, and double soil test. Overhead irrigation was by a Skinner sprinkler system and subirrigation was by means of 1/2 inch plastic pipe with .03-inch holes at one-foot intervals along the pipe. The pipe was buried one foot deep, and the pipes were spaced every three feet the length of the whole plot. Pressure was maintained at three pounds by a tank with a leveling float at the head of each subirrigation plot. As the irrigation pipe was placed

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[1] Mitchell, W. H., J. E. McIlvaine and J. P. Mueller, 1969. Subsurface irrigation with perforated plastic tubing. Delaware Ext. Bull. 99.

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[1] Mitchell, W. H., J. R. McIlvaine and J. P. Mueller, 1959. Subsurface irrigation with perforated plastic tubing. Delaware Ext. Bull. 59.

in the soil in April, 1968, spring oats were used as the small grain silage crop and planted after the pipe was installed. Alfalfa was also seeded after the pipe was installed.

Results

Planting and harvest dates are shown in Table 1, rainfall and irrigation in Table 2, and fertilizer treatments in Table 3. Yields are in Tables 4 through 8.

Rainfall was generally adequate and well distributed in April, May, and June, and therefore, little irrigation was needed until July. The overhead system worked satisfactorily, but problems were encountered with the underground system. Water moved down rapidly into the permeable subsoil, and almost no lateral movement took place. As a result, the alfalfa plants near the pipes suffered from saturated soil conditions, and the corn showed greater growth near the pipe than mid-way between pipes. Because of these problems, subirrigation was discontinued in early August. Better water distribution may be obtained in 1969 when the soil is more settled around the subirrigation pipe.

Alfalfa yields (Table 4) are rather low as would be expected from a seeding made in mid-April. A slight increase in yield was obtained from the high fertility treatments over the low treatments, especially where irrigation water was applied.

Corn grain yields (Table 5) were lowest in the nonirrigated plots and highest in the subirrigated plots. There was a trend, although not significant, for the medium and high fertilizer plots to outyield the low. Yields in all the grain plots were lower than would be expected. The single crop silage plots (Table 6) showed no differences between nonirrigated and subirrigated treatments. There was, however, a response to the high level

of fertilizer. Overhead irrigation, on the other hand, gave a substantial yield response under all three levels of fertilizer. The different response of grain and silage corn to overhead and subirrigation is difficult to explain. The only explanation that can be offered at this time is that there may be a difference in varietal response. The double-crop corn silage yields (Table 8) showed some response to high fertility, but only a slight trend toward an increase due to irrigation. Usually double-crop corn shows a substantial response to irrigation, but in 1968, rainfall early in the season, was adequate for plant growth following the removal of the small grain. In previous work, the total dry matter yield of the double-crop system was greater than for single-crop corn silage. This was not the case in this experiment where the highest single crop silage yield was 10.9 tons DM per acre compared with 5.8 tons DM from corn and 1.2 tons DM from oat silage.

Summary

Corn grain, corn silage and alfalfa were compared under three fertility levels; and with overhead irrigation, subsurface irrigation, and no irrigation. Rainfall in early summer was sufficient so that little irrigation water was needed until July. Overhead irrigation was satisfactory, but problems were encountered with the subsurface systems. The soil was saturated near the pipes, but at the wilting point between pipes. Because of this, irrigation was discontinued. Crops showed some yield response to irrigation and fertilizer.

Table 1. Planting and Harvest Schedules.

Crops	Planting date	Harvest date
Oats (Clinton)	4/10	6/14
Alfalfa (WL303)	4/15	7/4-8/13-10/15
Corn grain (DeKalb XL45)	5/14	11/15
Corn Silage (Pioneer 1097) (fallow)	5/14	10/4
Corn Silage (DeKalb XL45) (Double crop)	6/24	10/9

Table 2. Rainfall and Irrigation.

Month	Rainfall* (inches)	Irrigation Applied (inches)	
		Overhead	Subirrigation
April	9.4		
May	6.7	0.6	2.5
June	6.7	-	-
July	2.4	1.6	3.3
August	5.2	0.4	1.1
September	2.7	-	

*Recorded at Clarksville 3N

Table 3. Fertilizer Application.

Crop	Fertility Level	Fertilizer Applied N	P_2O_5	K_2O	How Applied
Oats	Low	6	12	12	Disked in before
	Medium	12	24	24	planting
	High	24	48	48	
Alfalfa	Low	6	12	12	Disked in before
	Medium	12	24	24	planting
	High	24	48	48	
Corn	Low	45	20	20	Plow down
Grain		10	10	10	planter
	Medium	90	40	40	Plow down
		20	20	20	planter
	High	180	80	80	Plow down
		40	40	40	planter
Corn	Low	66	30	30	Plow down
Silage		3.7	7.5	11.2	planter
(fallow	Medium	132	60	60	Plow down
and		7.5	15	22.4	planter
double crop)	High	264	120	120	Plow down
		15	30	45	planter

Table 4. Alfalfa Yields.

Irrigation Regime	Fertility Level	DM tons/acre 7/4 1st Harvest	8/13 2nd Harvest	10/15 3rd Harvest	Total
No	Low	0.9	0.6	0.5	2.0
Irrigation	Medium	1.0	0.5	0.5	2.0
	High	1.1	0.6	0.5	2.2
Sub-	Low	1.0	0.7	0.5	2.2
Irrigation	Medium	1.1	0.7	0.5	2.3
	High	1.2	0.7	0.6	2.5
Overhead	Low	0.9	0.8	0.5	2.2
Irrigation	Medium	1.0	0.8	0.6	2.4
	High	1.0	0.9	0.6	2.5

Table 3. Fertilizer Application.

Crop	Fertility Level	Fertilizer Applied N	P_2O_5	K_2O	How Applied
Oats	Low	6	12	12	Disked in before
	Medium	12	24	24	planting
	High	24	48	48	
Alfalfa	Low	6	12	12	Disked in before
	Medium	12	24	24	planting
	High	24	48	48	
Corn	Low	45	20	20	Plow down
Grain		10	10	10	planter
	Medium	90	40	40	Plow down
		20	20	20	planter
	High	180	80	80	Plow down
		40	40	40	planter
Corn	Low	66	30	30	Plow down
Silage		3.7	7.5	11.2	planter
(fallow	Medium	132	60	60	Plow down
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No	Low	0.9	0.6	0.5	2.0
Irrigation	Medium	1.0	0.5	0.5	2.0
	High	1.1	0.6	0.5	2.2
Sub-	Low	1.0	0.7	0.5	2.2
Irrigation	Medium	1.1	0.7	0.5	2.3
	High	1.2	0.7	0.6	2.5
Overhead	Low	0.9	0.8	0.5	2.2
Irrigation	Medium	1.0	0.8	0.6	2.4
	High	1.0	0.9	0.6	2.5

Table 5. Corn Grain Yields.*

Irrigation Regime	Fertility Level	Bushels/acre
None	Low	113
	Medium	123
	High	124
Subirrigation	Low	135
	Medium	133
	High	137
Overhead Irrigation	Low	122
	Medium	118**
	High	129

* Variety: DeKalb XL45 Population 25,600.

** Two plots in this treatment damaged by cows.

Table 6. Corn Silage Harvest Yields.*

Irrigation Level	Fertility Level	DM tons/acre	Adjusted 30% silage Tons/acre
No Irrigation	Low	6.6	21.9
	Medium	6.6	21.9
	High	7.9	26.3
Subirrigation	Low	6.8	22.6
	Medium	7.4	24.7
	High	7.7	25.7
Overhead Irrigation	Low	8.7	29.0
	Medium	9.5	31.7
	High	10.9	36.3

* Variety: Pioneer 1097 - Population 29,200.

Table 5. Corn Grain Yields.*

Irrigation Regime	Fertility Level	Bushels/acre
None	Low	113
	Medium	129
	High	126
Subirrigation	Low	135
	Medium	133
	High	137
Overhead Irrigation	Low	122
	Medium	118**
	High	129

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** Two plots in this treatment damaged by cows.

Table 6. Corn Silage Harvest Yields.*

Irrigation Level	Fertility Level	DM tons/acre	Adjusted 30% silage Tons/acre
No Irrigation	Low	6.6	21.9
	Medium	6.6	21.9
	High	7.9	26.3
Subirrigation	Low	6.8	22.6
	Medium	7.4	24.7
	High	7.7	25.7
Overhead Irrigation	Low	8.7	29.0
	Medium	9.3	31.7
	High	10.9	36.3

* Variety: Pioneer 1097 - Population 29,200.

Table 7. Oat Silage, Harvest Yields 1968.

Irrigational Regime	Fertility Level	Tons DM/acre
No Irrigation	Low	1.3
	Medium	1.0
	High	1.0
Subirrigation	Low	1.3
	Medium	1.3
	High	1.3
Irrigated	Low	1.2
	Medium	1.2
	High	1.2

Table 8. Corn Silage (Double Crop) Harvest Yields.

Irrigation Regime	Fertility Level	Green wt. T/A	DM T/A	30% DM Silage
None	Low	9.4	4.2	14.0
	Medium	10.9	5.0	16.7
	High	11.8	5.1	17.0
Subirrigation	Low	9.3	4.8	16.0
	Medium	11.3	4.9	16.3
	High	12.1	5.2	17.3
Overhead Irrigation	Low	11.6	4.6	15.3
	Medium	12.6	5.0	16.7
	High	14.7	5.8	19.3

Variety: DeKalb XL45 Population 25,700.

Table 7. Oat Silage. Harvest Yields 1968.

Irrigational Regime	Fertility Level	Tons DM/acre
No Irrigation	Low	1.3
	Medium	1.0
	High	1.0
Subirrigation	Low	1.3
	Medium	1.3
	High	1.3
Irrigated	Low	1.2
	Medium	1.2
	High	1.2

Table 8. Corn Silage (Double Crop) Harvest Yields.

Irrigation Regime	Fertility Level	Green wt. T/A	DM T/A	30% DM Silage
None	Low	9.4	4.2	14.0
	Medium	10.9	5.0	16.7
	High	11.8	5.1	17.0
Subirrigation	Low	9.3	4.8	16.0
	Medium	11.3	4.9	16.3
	High	12.1	5.2	17.3
Overhead Irrigation	Low	11.6	4.6	15.3
	Medium	12.6	5.0	16.7
	High	14.7	5.8	19.3

Variety: DeKalb XL45 Population 25,700.

The Effects of Variety, Selection, and Production Methods of Corn on the Feeding Value of Corn Silage

N. A. Clark
Department of Agronomy

Purpose and Objectives

The overall project objectives of this study are to determine the effects of genetically controlled morphology, planting rate, soil nutrient relationships, and time of harvest on the following components of silage corn:

1. yield
2. ear-stalk ratio
3. fiber and lignin content
4. protein content
5. nitrate content
6. TDN
7. ripening characteristics

This research is being conducted in cooperation with the Department of Dairy Science as most of our silage work is cooperative between the two departments. There is presently interest among dairy nutritionists in feeds low in potassium. Our immediate objective was to produce corn silage with low to high ranges of K, and also to study the effect of K balance on nitrate nitrogen, carbohydrates, and other minerals in the plant tissue.

Procedure

The experiment was set up as an incomplete factorial consisting of the following fertilizer treatments:

1. Check
2. N
3. K
4. Mg
5. Ca
6. N + K
7. N + Mg
8. K + Mg
9. K + Ca
10. N + K + Mg

The experimental design was a randomized complete block with 4 replications. Each plot consisted of four 30-inch rows, 30 feet in length. The plant population was 32,000. The following sources were used to supply the elements listed above:

N - ammonium nitrate

K - potassium chloride

Mg - magnesium sulfate

Ca - ground agricultural limestone

N was applied at 300 pounds per acre, K at 500 pounds per acre, Mg at 300 pounds per acre, and CaO at 2000 pounds per acre all of which passes a 20 mesh screen and 60 percent of which passes a 100 mesh screen. Phosphorous was applied uniformly over the entire experimental area at a rate of 130 pounds per acre. All the materials were applied with a Gandy spreader and disked in immediately before planting. The corn was planted on May 10 using the variety Pioneer 1097. Immediately after planting, the entire area was sprayed with 4 pounds of atrazine per acre.

Plant samples were taken at random from each plot at the twelve-leaf stage, silking stage, and silage stage. The plants were divided into stalks and leaves, and for the last sampling the cobs and kernels were also collected separately. To date, only the first harvest which was made on July 12 has been analyzed for nitrate-N, carbohydrates, P, Ca, K, and Mg for both the leaves and the whole plants.

Results

The results of the chemical analyses of the first harvest are shown in Tables 1 and 2. These data show that nitrate was higher in the whole plants than in the leaves alone. It is also evident that plots receiving N had higher nitrate contents than the others, although none of the levels found

were in the high range. Carbohydrates were lower in plots treated with K than in the other plots. Phosphorous was taken up uniformly regardless of treatment. Ca was generally highest in plants from the Ca-treated plots and those which received N. Potassium levels in the tissue were decreased by additions of N, Mg, and Ca. Magnesium in the tissue was highest in the Mg-treated plots and lowest in the K-treated plots.

Summary

Corn grown under high and low levels of N, K, Mg, and Ca was analyzed for nitrate N, carbohydrates, P, K, Ca, and Mg. Nitrate, although not present at high levels, was higher on the plots treated with N. Carbohydrates were lowest in plants from the K treatment plots. Phosphorous in the tissue was uniform over all treatments, while K, Ca, and Mg were all highest in tissue from plots where these elements were applied.

Table 1. First harvest means for nitrate, N, carbohydrates, percent P, Ca, K, and Mg for corn - whole plant. (July 12, 1968)

Treatment	NO_3-N %	Carbohydrates mgm/mgm	P %	Ca %	K %	Mg %
Check	0.08	0.27	0.29	0.53	2.1	0.35
N	0.26	0.28	0.31	0.59	1.7	0.44
K	0.08	0.15	0.31	0.51	4.6	0.32
Mg	0.06	0.28	0.30	0.52	2.2	0.40
Ca	0.15	0.29	0.30	0.60	1.4	0.41
N + K	0.18	0.15	0.29	0.55	4.3	0.36
N + Mg	0.30	0.24	0.30	0.59	2.2	0.45
K + Mg	0.06	0.15	0.32	0.51	4.4	0.36
K + Ca	0.12	0.12	0.31	0.62	4.9	0.35
N + K + Mg	0.28	0.14	0.30	0.55	5.2	0.36

Table 1. First harvest means for nitrate, N, carbohydrates, percent P, Ca, K, and Mg for corn - whole plant. (July 12, 1960)

Treatment	NO_3-N	Carbohydrates	P	Ca	K	Mg
	%	ugm/ugm	%	%	%	%
Check	0.08	0.27	0.20	0.33	2.1	0.35
N	0.26	0.28	0.31	0.56	1.7	0.44
K	0.08	0.15	0.31	0.51	4.6	0.32
Mg	0.06	0.28	0.30	0.52	2.2	0.40
Ca	0.15	0.25	0.30	0.60	1.4	0.41
N + K	0.18	0.15	0.25	0.55	4.3	0.36
N + Mg	0.30	0.24	0.30	0.50	2.2	0.45
K + Mg	0.06	0.15	0.32	0.51	4.4	0.36
K + Ca	0.12	0.12	0.31	0.62	4.5	0.32
N + K + Mg	0.28	0.14	0.30	0.55	5.2	0.36

Table 2. First harvest means for nitrate N, carbohydrates, percent P, Ca, K, and Mg for corn leaves. (July 12, 1968)

Treatment	Nitrate N %	Carbohydrates mgm/mgm	P %	Ca %	K %	Mg %
Check	0.06	0.18	0.29	0.43	1.7	0.29
N	0.06	0.15	0.32	0.46	1.5	0.34
K	0.03	0.13	0.28	0.41	2.7	0.28
Mg	0.03	0.20	0.30	0.40	1.6	0.31
Ca	0.04	0.20	0.31	0.45	1.3	0.32
N + K	0.06	0.15	0.28	0.45	2.6	0.28
N + Mg	0.08	0.17	0.31	0.45	1.4	0.36
K + Mg	0.03	0.14	0.29	0.41	2.6	0.28
K + Ca	0.04	0.14	0.29	0.42	2.7	0.25
N + K + Mg	0.07	0.10	0.30	0.43	2.7	0.28

Table 2. First harvest means for nitrate N, carbohydrates, percent P, Ca, K, and Mg for corn leaves. (July 12, 1958)

Treatment	Nitrate N %	Carbohydrates mgm/mgm	P %	Ca %	K %	Mg %
Check	0.06	0.18	0.29	0.43	1.7	0.29
N	0.06	0.15	0.32	0.46	1.5	0.24
K	0.03	0.13	0.28	0.41	2.7	0.28
Mg	0.03	0.20	0.30	0.40	1.6	0.31
Ca	0.04	0.20	0.31	0.45	1.3	0.32
N + K	0.06	0.15	0.28	0.45	2.6	0.28
N + Mg	0.08	0.17	0.31	0.45	1.4	0.36
K + Mg	0.03	0.14	0.25	0.41	2.6	0.28
K + Ca	0.04	0.14	0.25	0.42	2.7	0.25
N + K + Mg	0.07	0.10	0.30	0.43	2.7	0.28

Studies on Flaming for Control of the Alfalfa Weevil

N. A. Clark
Department of Agronomy

Purpose and Objectives

There is much concern over the use of insecticides on forage fed to milking cows because of possible contamination of the milk. Flaming offers the possibility of controlling the alfalfa weevil without the danger of contaminating the alfalfa.

The specific objectives were to determine:

1. The effects of dormant and stubble flaming on weevil and weed control.
2. The effects of time of harvest on weevil control and alfalfa yield and quality.
3. The combined effects of flaming and early harvest on weevils and weed control and on alfalfa yield and quality.

Procedure

Experimental plots were established on Williamsburg alfalfa at the Agronomy-Dairy Forage Research Farm at Clarksville. The plots were 100 x 100 feet in a randomized complete block design with three replications. Flaming or insecticide spray treatments were combined with early or normal harvest and were as follows:

Treatment No.	Treatment	Harvest
1	Dormant flame - fall and spring	Early
2	Dormant flame - spring	Early
3	Dormant flame - spring - stubble flame	Early
4	Stubble flame	Early
5	Stubble spray	Early
6	Foliar spray	Early
7	Dormant flame - spring	Normal
8	Foliar spray (standard treatment)	Normal

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Procedure

Experimental plots were established on Williamsburg alfalfa at the Agronomy-Dairy Forage Research Farm at Clarkeville. The plots were 100 x 100 feet in a randomized complete block design with three replications. Flaming or insecticide spray treatments were combined with early or normal harvest and were as follows:

Treatment No.	Treatment	Harvest
1	Dormant flame - fall and spring	Early
2	Dormant flame - spring	Early
3	Dormant flame - spring - stubble flame	Early
4	Stubble flame	Early
5	Stubble spray	Early
6	Foliar spray	Early
7	Dormant flame - spring	Normal
8	Foliar spray (standard treatment)	Normal

Early harvest plots were cut approximately one week before the current recommended "full bud stage".

Flaming treatments were applied at 3 mph using the machine developed by Harris[1]. The fall dormant flame treatment (no. 1) was applied December 15, 1967. The spring dormant flame treatments were applied on March 26. On April 17, plots were checked for weevil damage. Treatments 1 through 6 were harvested on April 30; spray and flame stubble treatments were applied on May 6. The spray was a combination of methoxychlor and malathion.

The effect of treatments on alfalfa plant stand and weed cover was determined from a 12 by 24 inch area in each plot. The area was located by random placement of pegs within each plot. A 12- by 24-inch frame quadrat was positioned over the pegs to obtain plant and weed counts before and after application of treatments. Weed cover was recorded as the percent of coverage within the sample area. Alfalfa plant stand was determined by measuring the linear inches of continuous plants within the rows encompassed by the quadrat and expressed as percent of full stand.

Measurements of weed cover and alfalfa stand were made December 6, 1967 and March 25, 1968. Yield data were from a 30-feet by 34-inch strip taken at random from each plot. Plant samples taken at harvest were anlayzed for crude protein and for acid detergent fiber by the method of Van Soest[2].

Analysis of variance was performed for most sets of data and treatment means were compared at the 5% level of significance. Means with the same letter do not differ significantly.

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[1]Harris, W. L. Design of an LP-Gas burner for field flaming. Proceedings of Fifth Symposium on Thermal Agriculture, pp. 16-19, January 1968. Natural Gas Processors Association. Tulsa, Oklahoma.

[2]Van Soest, P. J. Use of Detergents in the Analysis of Fibrous Feeds. II. A Rapid Method for the Determination of Fiber and Lignin. JADAC 46(5): 829-835, 1963.

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[1] Harris, W. L. Design of an LP-Gas burner for field flaming. Proceedings of Fifth Symposium on Thermal Agriculture, pp. 15-19, January 1968. National Gas Processors Association. Tulsa, Oklahoma.

[2] Van Soest, P. J. Use of Detergents in the Analysis of Fibrous Feeds. II. A Rapid Method for the Determination of Fiber and Lignin. JAOAC 46(5): 829-835, 1963.

Results

Experimental results are shown in Table 1. The percentage of stems infested on April 17 indicated significantly lower infestion in flamed plots than in unflamed plots, (compare 1, 2, 7 with 5, 6, 8) except for one comparison (treatment 3 with 4). Plant damage ratings made on April 30, show significantly lower damage in all flamed plots (compare treatments 1, 2, 3, 7 with 4, 5, 6, 8). Larvae per sweep on May 1 indicate similar trends; however, fewer comparisons are significant at the 5% level.

Damage ratings made on June 3, after first cutting of both early and normal harvest plots, indicated significant difference between early harvest plots treated with insecticide or stubble flamed and untreated plots (compare treatments 3, 4, 5 with 1, 2, 6). In one comparison (4 with 5), an application of insecticide was significantly better than stubble flame; however, in another comparison (3 with 5) the difference between treatments was not significant. In general, the application of insecticide on the stubble after first cutting was more effective than an application of thermal energy.

The data for the two normal harvest treatments are rather interesting. All measurements (stems infested, plant damage and larvae per sweep) made prior to first cutting showed significantly lower values for the flamed treatment (no. 7) than for the unflamed treatment (no. 8). After first cutting, no additional treatments were applied to either set of plots. However, the plant damage ratings on June 3 indicated a significantly lower damage (19.2%) for treatment 8 than for treatment 7 (54.2%). Insect migration may have contributed to the results obtained.

Weed infestation, primarily chickweed, was severe, though somewhat variable throughout the experimental area, as indicated by the December 6, 1967 measurements. The fall thermal treatment (December 15, 1967) signifi-

cantly reduced the chickweed present in flamed plots on March 25, 1968. The alfalfa stand was not affected by the fall flaming and no measurement of plant stand was made subsequent to the spring thermal treatments.

Significant differences in first cutting yields were obtained between the early harvest plots and the normal harvest plots. Yields from the early harvest plots cut on April 30, were lower than the yields from the normal harvest plots cut on May 13. There were no significant yield differences among treatments within the early or normal harvest plots. Second and third times of harvest were the same for both groups of treatments and the yields were not significantly different. The total yield data for the three cuttings indicated no significant differences among treatments or between early and normal harvest groups.

The higher yields of May 13 harvest were probably due to the advanced maturity of the plants, which is supported by the significantly higher fiber content of the plants. Plants samples from early harvest plots that received a dormant thermal treatment had protein contents significantly higher than all other treatments. The difference in protein content could be due to a change in leaf stem ratio and reduction in old residue by flame treatment. Additional study is needed to determine the reasons for differences in the protein content.

Summary

Results indicated that two control applications were required for full season protection. Early harvest alone had little or no effect on plant damage prior to second cutting. However, data from normal harvest treatments indicated the least damage on second cutting material from plots that had received neither flaming nor spray treatments. This indicates that some degree of control may be obtained if the insect activity and harvest dates coincide.

Good control was achieved on first cutting by a dormant flame treatment. The plots receiving two dormant flamings (fall and spring) were the least damaged; however, differences between the two applications and only one in the spring were significant in only one case.

The use of an insecticide on stubble after early harvest provided better protection than stubble flaming. Plots dormant flamed and then stubble flamed were not significantly different from plots that were stubble sprayed.

Plots that received two dormant flame treatments had significantly lower weed infestation than all other treatments. All flame treatments reduced the percentage of weed cover; however, due to wide variations in data the results were not significantly different from unflamed plots.

The first cutting yields of early harvest plots were significantly lower than the first cutting yields from normal harvest plots. However, there were no significant differences among total yield data for the three cuttings. The fiber content of first cutting samples was significantly higher from the normal harvest plots than from the early harvest plots. First cutting samples from early harvest plots that received a dormant flame treatment had protein contents significantly higher than all other treatments.

TABLE 1. Effect of Flaming and Time of Harvest on Alfalfa Weevil, Weed Cover and Alfalfa Yield and Quality. Maryland, 1968.

TREATMENT & NO.		ALFALFA PLANTS - % (12/6/67)	(3/25/68)	WEED COVER - % (12/6/67)	(3/25/68)	STEMS INFESTED - % (4/17/68)	LARVAE PER SWEEP (5/1/68)	PLANT DAMAGE - % (4/30)	(6/3)	YIELD - WEED FREE ALFALFA 1st CUTTING (4/30/68)	2nd CUTTING (7/1/68)	TONS DM/A TOTAL	FIRST CUTTING FIBER %	FIRST CUTTING PROTEIN %
EARLY HARVEST														
Dormant Flame 12/15/67 3/26/68	1	56	54	100	21a	6.7a	1.6a	0.7a	86.7cd	0.9a	1.0	3.2	22.0a	25.5b
Dormant Flame 3/26	2	90	81	46	59b	6.7a	4.3abc	32.7a	94.2cd	1.0a	0.9	3.0	22.1a	24.9b
Dormant Flame 3/26 Stubble Flame 5/6	3	65	77	100	62b	13.3ab	8.6abc	22.0a	35.0a	1.0a	1.1	3.2	22.6a	26.0b
Stubble Flame 5/6	4	73	69	100	65b	33.4bc	13.7abcd	68.3b	55.8b	1.1a	1.1	3.5	21.8a	23.1a
Stubble Spray 5/6	5	58	54	100	100b	40.0c	16.5bcd	66.7b	29.2a	1.2a	1.0	3.3	23.6a	22.8a
Foliar Spray*	6	63	54	100	100b	35.6c	18.3cd	69.2b	74.2c	1.1a	1.2	3.6	21.0a	22.3a
NORMAL HARVEST														
Dormant Flame 3/26	7	73	48	75	79b	4.4a	3.5ab	2.7a	54.2b	1.8b	0.9	3.8	27.7b	22.3a
Foliar Spray	8	65	56	75	100b	62.3d	25.8d	69.8b	19.2a	1.5b	1.0	3.6	27.1b	20.8a

*Plots were not sprayed prior to first cutting.

Breeding and Evaluation of Kentucky Bluegrass for Turf

E. E. Deal
Department of Agronomy

Purpose and Objectives

Numerous new varieties and selections of Kentucky bluegrass have been placed on the market before their performance was adequately evaluated. The purpose of this project is to evaluate varieties and selections that may have potential in Maryland and the Northeast. Current evaluation systems are being studied and an attempt is being made to develop improved methods of assessing turf quality. The ultimate goal is development of better adapted varieties of Kentucky bluegrass for Maryland and the Northeast.

Procedures

Germplasm of commercially available varieties and promising new selections were planted in a uniform variety evaluation study for Maryland and the Northeast. In addition to a basic test which will be maintained by each participating state, multiple plantings were made by some states for other studies, such as response to mowing heights or fertilizer applications. Currently used evaluation methods such as visual ratings of overall quality, turf density, green color, etc. will be used on a uniform basis and new techniques will be developed and studied.

Forty-two varieties and selections of Kentucky bluegrass were seeded in the fall of 1968 and two more will be added in 1969 in the Maryland study. Two 3-replication studies were planted at the University of Maryland Plant Research Farm--one to be mowed at 1½ inches, the other at 2½ inches. Another 3-replication study was planted near Centreville, Maryland.

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Two 3-replication plantings of red fescue containing 16 varieties and selections each were also made in the fall of 1968. One planting was in a sunny location at the Plant Research Farm, the other in a heavily shaded location on the College Park Campus of the University.

Results

Germination and fall growth of all Kentucky bluegrasses were good. Red fescues planted in the sunny location germinated and grew well but were poor in the shade. Regular evaluations will begin in the Spring of 1969 on all plots.

Summary

A new device known as a "Ratiospect" designed for determining light absorption at two predetermined wave lengths has been used on other turf studies to check its accuracy and effectiveness. Originally expected to measure turf color, it now appears that several other factors affect the light absorption. Such factors appear to include turf density, leaf width, angle of growth of the leaves and background color within the stand of turf itself. Further studies must be made to determine exactly how much each of these factors, and perhaps others, influence readings made with this device. Early indications are that these data can be rather closely correlated with overall turf quality.

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Tufcote Bermudagrass - Adaptations and Requirements for Turf Uses

E. E. Deal
Department of Agronomy

Purpose and Objectives

Tufcote is a relatively new variety of bermudagrass which was developed for turf uses. Until recently very little has been known of its management requirements for athletic fields, fairways, play areas, lawns, and similar turf areas. This series of experiments was designed to study its turf quality and persistence under several different management programs. Objectives were to establish fertilization and mowing procedures for production of high quality turf; determine which cool-season grasses are best suited for overseeding established Tufcote for improved winter color; and determine the effects of fertilization and mowing practices on winter survival of the Tufcote and summer survival of the cool season grasses.

Procedures

Experiment A (Fertilization). Three forms of nitrogen were applied at different rates and at different dates during the summer months. Forms of nitrogen included a quickly available source (urea), a slowly available synthetic organic source (ureaformaldehyde), and a slowly available natural organic source (processed organic wastes, Agrinite). Rates were 3 to 9 lbs. N per 1000 sq. ft. per year in single and multiple applications.

Experiment B (Overseeding). Annual and perennial cool-season turfgrass species were overseeded into established bermuda turf in the fall. Grasses included ryegrass, bentgrass, Kentucky bluegrass, rough bluegrass, and fescues. Mowing heights were 1 and 2 inches.

Experiment C (Mowing). Mowing heights of 1/2, 1, 1½ inches in all combinations with mowing intervals of 2, 3, 7, and 14 days were maintained throughout the growing season.

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Experiment C (Mowing). Mowing heights of 1/2, 1, 1½ inches in all combinations with mowing intervals of 2, 3, 7, and 14 days were maintained throughout the growing season.

Turfgrass response was evaluated by making visual ratings of color, density, and overall quality of the turf, plant density counts, stored food reserve determinations, and periodic evaluations of plant populations (overseeding study only).

A new experimental device known as a "Ratiospect" which measures light intensity is also being used to evaluate turf quality. Data from this device are being compared with conventional measurements to determine its accuracy and effectiveness as a means of assessing turf quality.

Results

Experiment A (Fertilization). Response of Tufcote bermuda to the various rates and forms of nitrogen has been about the same as reported with other bermudas. The soluble source (urea) gave a quick growth response but it was relatively short lived. Quality was excellent with this form if the nitrogen was applied in relatively small amounts but at frequent intervals, e.g. 1 pound per month. Ureaformaldehyde gave a much slower response, and a given rate did not give the same quality of turf as urea. The natural organic source has been intermediate in giving a growth response but turf quality has been good. Single applications of either form, even at the high rate of 9 lbs., have not given a uniform turf throughout the growing season.

Ratiospect readings closely parallel turf quality ratings. This device appears to give a better measure of overall quality (color, density, appearance, etc.) than it does of color alone.

Experiment B (Overseeding). Annual ryegrass germinated and grew faster in the fall than any other grass overseeded into the bermuda. Rough bluegrass was somewhat slower. Tall fescue and bentgrass were intermediate in rate of establishment and Kentucky bluegrass was the slowest. In late spring, however, overall turf quality was about the reverse of the rate of fall growth, i.e.

slow growing grasses in fall looked good in spring and fast growing fall grasses started to fade out earlier in the season. Transition from ryegrass back to bermuda in late spring was too rapid, leaving a period of time when there was little good turf cover. Rough bluegrass was intermediate.

Mowing heights in 1968 made a striking difference in summer persistence of the cool-season grasses. The overseeded grasses largely disappeared at the 1-inch mowing height but at the 2-inch height the bluegrass, tall fescue, red fescue, and bentgrass remained very prominent in the turf (Table 1).

Experiment C (Mowing). Highest quality Tufcote bermudagrass turf was produced when it was mowed frequently and close. Mowing at 2- to 3-day intervals and at a height of 1 inch was best generally. Less frequent and/or taller mowing resulted in poorer quality although turf in all plots was acceptable. Turf mowed every 2 weeks was poor for a few days after mowing due to the "scalped" appearance, especially at the low heights, but this did not appear to affect its persistence (Table 2).

Winter survival has not been a problem in any of these experiments to date. Bermuda in all treatments has survived the winters without difficulty.

Summary

Tufcote bermudagrass is adapted for use as a grass cover on several different types of turfgrass areas. Either of the three nitrogen sources discussed above can be used successfully to supply nitrogen for this grass, but each must be managed somewhat according to its nitrogen release characteristics. Light frequent applications with all sources gave the most uniform growth pattern. Annual ryegrass gave faster fall turf cover than other cool-season grasses used for winter overseeding in this experiment, but it disappeared faster in the spring. Kentucky bluegrass, tall fescue, red fescue,

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and Highland bentgrass gave good spring and early summer cover but were very slow establishing in the fall. Rough bluegrass was intermediate. Mowing at 2- to 3-day intervals at 1 inch appears to be the best mowing practice for most turf uses. Each phase of this study is being continued.

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Table 1. Percent coverage of Tufcote bermudagrass and overseeded grasses in early spring and in fall, 1968.

Cool-Season Grass	Seeding Rate Lb/1000	Percent Green Cover 3/68	Turf Cover and Quality - 10/68					
			2" Mowing Height			1" Mowing Height		
			Percent Cover		Quality Rating	Percent Cover		Quality Rating
			Tufcote	Other		Tufcote	Other	
None[1]	-	0[3]	100	0	8.0[4]	100	0	10.0[4]
None[2]	-	7	98	1	7.0	100	0	9.3
Annual Ryegrass	7	67	98	1	7.3	100	0	10.0
Annual Ryegrass	14	82	98	1	7.3	100	0	9.7
Highland Bentgrass	½	45	52	43	4.7	85	13	8.3
Highland Bentgrass	1	58	42	58	6.0	83	17	8.7
Pennlawn Red Fescue	2	42	77	23	5.0	95	5	9.0
Pennlawn Red Fescue	4	45	72	28	5.0	96	4	8.3
Kentucky 31 Tall Fescue	3	10	55	45	6.3	96	4	10.0
Kentucky 31 Tall Fescue	5	23	52	48	7.0	95	5	9.7
Kentucky 31 Tall Fescue	7	25	47	53	6.3	91	90	10.0
Merion Ky. Bluegrass	1½	18	17	83	7.7	58	42	10.0
Merion Ky. Bluegrass	3	38	28	72	8.3	53	47	10.0
Rough Bluegrass	1½	70	91	5	5.0	98	1	9.0
Rough Bluegrass	3	85	93	4	5.7	98	1	9.0

[1]Not verticut or overseeded.

[2]Verticut but not overseeded.

[3]Tufcote dormant at this time.

[4]Rating scale: 10 = best.

Table 1. Percent coverage of Thatch grasses and Dwarf grasses by early spring and in fall: 1958.

Grass-Species Composition	Spring Race	1958 Count	Percent Count	Fall 1958 Count	Percent Count	Spring 1959 Count	Percent Count	Fall 1959 Count	Percent Count
Thatch Grasses									
Kentucky bluegrass	Ky	82	82	98	98	98	98	100	100
Canada bluegrass	Ky	10	10	2	2	2	2	0	0
Rough bluegrass	Ky	3	3	0	0	0	0	0	0
Total		95	95	100	100	100	100	100	100
Dwarf Grasses									
Redtop	Ky	2	2	0	0	0	0	0	0
Velvet bentgrass	Ky	1	1	0	0	0	0	0	0
Colonial bentgrass	Ky	1	1	0	0	0	0	0	0
Creeping bentgrass	Ky	-	-	0	0	0	0	0	0
Annual bluegrass	Ky	1	1	0	0	0	0	0	0
Total		5	5	0	0	0	0	0	0
Other Species									
Quackgrass	Ky	2	2	0	0	0	0	0	0
Smooth brome	Ky	3	3	0	0	0	0	0	0
Orchard	Ky	4	4	0	0	0	0	0	0
Timothy	Ky	1	1	0	0	0	0	0	0
Total		10	10	0	0	0	0	0	0
Grand Total		100	100	100	100	100	100	100	100

Turf Cover and Quality - 1959

1/ Spring Method

Turf Cover Method

Treatment	Rate 1000 sq ft	Spring Race	Cover Percent	Quality Rating
Check	-	-	0	4.0
Aeration Spring	1	Ky	82	7.5
Aeration Fall	1	Ky	45	6.3
Aeration Spring Fall	1	Ky	52	6.0
Aeration Spring Fall	2	Ky	82	7.3
Aeration Spring Fall	3	Ky	98	8.4
Aeration Fall Fescue	1	Ky	25	5.0
Aeration Fall Fescue	2	Ky	38	6.3
Aeration Fall Fescue	3	Ky	43	7.0
Aeration Fall Bluegrass	1	Ky	28	5.0
Aeration Fall Bluegrass	2	Ky	33	6.3
Aeration Fall Bluegrass	3	Ky	38	7.0
Aeration Spring Fescue	1	Ky	17	5.0
Aeration Spring Fescue	2	Ky	22	6.0
Aeration Spring Fescue	3	Ky	25	7.0
Aeration Spring Bluegrass	1	Ky	12	5.0
Aeration Spring Bluegrass	2	Ky	15	6.0
Aeration Spring Bluegrass	3	Ky	18	7.0
Aeration Spring	1	Ky	10	5.0
Aeration Spring	2	Ky	33	6.3
Aeration Spring	3	Ky	38	7.0
Aeration Fall	1	Ky	25	5.0
Aeration Fall	2	Ky	33	6.3
Aeration Fall	3	Ky	38	7.0

Table 2. Turf quality, color, and density ratings of Tufcote Bermudagrass before and after mowing as affected by mowing height and frequency.

Mowing Practice	Quality		Color		Density	
	Before	After	Before	After	Before	After
½ inch						
2-Day interval	10.0[1]	8.0	10.0	8.7	9.5	8.7
3-Day interval	9.3	8.7	10.0	8.3	9.5	8.7
7-Day interval	8.7	7.0	10.0	6.7	9.5	7.0
14-Day interval	7.0	4.3	10.0	4.7	9.5	5.3
1 inch						
2-Day interval	9.0	9.3	10.0	9.7	9.5	9.7
3-Day interval	9.0	9.3	10.0	9.7	9.5	9.0
7-Day interval	8.3	7.3	10.0	7.3	9.5	7.0
14-Day interval	6.7	4.7	10.0	5.0	9.5	5.7
1½ inches						
2-Day interval	8.3	8.7	10.0	9.3	9.5	8.7
3-Day interval	7.7	8.0	10.0	8.3	9.5	8.3
7-Day interval	7.7	6.0	10.0	7.0	9.5	6.7
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[1]Rating scale: 10 = best.

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14-Day Interval	7.0	4.3	10.0	4.7	9.5	5.3
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7-Day Interval	8.3	7.3	10.0	7.3	9.5	7.0
14-Day Interval	6.7	4.7	10.0	5.0	9.5	5.7
1½ inches						
2-Day Interval	8.3	8.7	10.0	9.3	9.5	8.7
3-Day Interval	7.7	8.0	10.0	8.3	9.5	8.3
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14-Day Interval	6.0	5.0	10.0	4.7	9.5	5.7

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Management of Kentucky-31 Tall Fescue for Park, Playground and Athletic Field Turf

E. E. Deal
Department of Agronomy

Purpose and Objectives

Tall fescue is gaining in favor each year as a tough, durable grass for use on turf areas which receive heavy use. The purpose of this study was to learn more about its wear resistance under different management programs. Specific objectives were: determine the best seeding rate for tall fescue alone and in mixtures with other grasses; investigate the influence of two mowing heights on persistence of these grasses; and, determine the resistance of tall fescue and mixtures containing tall fescue to repeated scuffing and cleating.

Procedure

Kentucky 31 tall fescue was seeded in 1964 at rates of 3, 5, and 7 lbs. per 1000 square feet both alone and in mixtures with other perennial cool-season grasses. A 9-lb. rate was also seeded alone. Rates of seeding and mixtures can be found in Table 1. Mowing heights of 1½ and 2½ inches have been maintained across each plot since early 1965. All plots have received 3 lbs. of N per 1000 square feet per year and half of each plot has received an additional application of 1 to 2 lbs. of N in late spring and early summer. Since early 1967 each subplot has been subjected to severe and moderately severe traffic once per week throughout the growing season, March through November. Periodic ratings of turf quality and estimates of turf cover and composition have been made each year.

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Procedure

Kentucky 31 tall fescue was seeded in 1954 at rates of 3, 5, and 7 lbs. per 1000 square feet both alone and in mixtures with other perennial cool-season grasses. A 9-lb. rate was also seeded alone. Rates of seeding and mixtures can be found in Table 1. Mowing heights of 1½ and 2½ inches have been maintained across each plot since early 1955. All plots have received 3 lbs. of N per 1000 square feet per year and half of each plot has received an additional application of 1 to 2 lbs. of N in late spring and early summer. Since early 1957 each subplot has been subjected to severe and moderately severe traffic once per week throughout the growing season, March through November. Periodic ratings of turf quality and estimates of turf cover and composition have been made each year.

Results

Tall fescue seeded alone at either seeding rate or in combination with Pennlawn red fescue has produced turf that was inferior to tall fescue mixed with Kentucky bluegrasses. Bluegrasses appear to dominate the mixture faster than red fescue. Texture of the turf is much poorer with the red fescue mix because of the marked difference in leaf texture. Mixtures with Merion and Windsor have been slightly superior to those with common Kentucky bluegrass in these mixtures.

Tall fescue content has remained slightly higher in the mixtures at the 2½-inch mowing height, and this turf was much more resistant to traffic injury. The amount of traffic has made little difference in turf cover or quality at the lower mowing height. At the 2½-inch height, turf cover has been much better at the lower level of traffic and compaction.

Statistical analyses have not been completed on data from this study. Averages are given in Tables 1-3.

Summary

Turf cover and overall turf quality have been much higher in plots seeded with tall fescue-Kentucky bluegrass mixtures than in plots where the tall fescue was seeded alone or in combination with Pennlawn red fescue. The turf was much more resistant to traffic injury when mowed at a 2½-inch mowing height than when mowed at 1½ inches.

Results

Tall fescue seeded alone at either seeding rate or in combination with Pennlawn red fescue has produced turf that was inferior to tall fescue mixed with Kentucky bluegrasses. Bluegrasses appear to dominate the mixture faster than red fescue. Texture of the turf is much poorer with the red fescue mix because of the marked difference in leaf texture. Mixtures with Merion and Windsor have been slightly superior to those with common Kentucky bluegrass in these mixtures.

Tall fescue content has remained slightly higher in the mixtures at the 2½-inch mowing height, and this turf was much more resistant to traffic injury. The amount of traffic has made little difference in turf cover or quality at the lower mowing height. At the 2½-inch height, turf cover has been much better at the lower level of traffic and compaction.

Statistical analyses have not been completed on data from this study. Averages are given in Tables 1-3.

Summary

Turf cover and overall turf quality have been much higher in plots seeded with tall fescue-Kentucky bluegrass mixtures than in plots where the tall fescue was seeded alone or in combination with Pennlawn red fescue. The turf was much more resistant to traffic injury when mowed at a 2½-inch mowing height than when mowed at 1½ inches.

Table 1. Total percent cover of turf with tall fescue seeded alone and in mixtures, mowed at two heights and subjected to moderately heavy (1X) and heavy (2X) traffic. 1968.

Grass (lb/1000 ft.^{2})	Mowing Height 1½ Inches 1X* %	1½ Inches 2X %	2½ Inches 1X %	2½ Inches 2X %	Ave. %
Ky-31 Tall Fescue (3)	23%	18%	79%	45%	41%
Ky-31 + Pennlawn RF** (2)	22	30	85	57	48
Ky-31 + Windsor KB** (1)	68	71	98	85	81
Ky-31 + Merion KB (1)	40	55	96	75	67
Ky-31 + Com. KB (1)	42	38	87	72	60
Ky-31 + Merion + Com. KB (1)	57	55	95	70	69
Ky-31 Tall Fescue (5)	20	13	83	37	38
Ky-31 + Pennlawn RF (2)	20	25	88	65	50
Ky-31 + Windsor KB (1)	54	56	98	78	71
Ky-31 + Merion KB (1)	57	65	97	65	71
Ky-31 + Com. KB (1)	38	28	92	82	60
Ky-31 + Merion + Com. KB (1)	42	64	98	80	71
Ky-31 Tall Fescue (7)	20	22	90	63	49
Ky-31 + Pennlawn RF (2)	20	20	94	68	51
Ky-31 + Windsor KB (1)	58	70	95	77	75
Ky-31 + Merion KB (1)	45	43	94	70	63
Ky-31 + Com. KB (1)	32	43	93	78	62
Ky-31 + Merion + Com. KB (1)	40	40	98	75	63
Ky-31 Tall Fescue (9)	18	20	88	65	48
Ky-31 Tall Fescue (7) + Penncross Bentgrass (1)	23	18	63	35	35
Average	37	40	91	67	59

* 1X = 1 trip over with traffic machine on each date.
2X = 2 trips over.

**RF = Red Fescue, KB = Kentucky bluegrass.

Table 1. Total percent cover of turf with tall fescue seeded alone and in mixtures, mowed at two heights and subjected to moderately heavy (1X) and heavy (2X) traffic. 1968.

Grass	(lb/1000 ft.^{2})	Mowing Height				
		1½ Inches		2½ Inches		Ave.
		1X*	2X	1X	2X	
		%	%	%	%	%
Ky-31 Tall Fescue (3)		23%	18%	79%	45%	41%
Ky-31 + Pennlawn KB** (2)		22	30	85	57	48
Ky-31 + Windsor KB** (1)		58	71	98	85	81
Ky-31 + Merlon KB (1)		40	55	96	75	67
Ky-31 + Com. KB (1)		42	36	87	72	60
Ky-31 + Merlon + Com. KB (1)		57	55	95	70	69
Ky-31 Tall Fescue (5)		20	13	83	37	38
Ky-31 + Pennlawn KF (2)		20	25	88	65	50
Ky-31 + Windsor KB (1)		54	56	98	78	71
Ky-31 + Merlon KB (1)		57	65	97	65	71
Ky-31 + Com. KB (1)		38	28	92	82	60
Ky-31 + Merlon + Com. KB (1)		42	64	98	80	71
Ky-31 Tall Fescue (7)		20	22	90	63	49
Ky-31 + Pennlawn KF (2)		20	20	94	68	51
Ky-31 + Windsor KB (1)		58	70	95	77	75
Ky-31 + Merlon KB (1)		45	43	94	70	63
Ky-31 + Com. KB (1)		32	43	93	78	62
Ky-31 + Merlon + Com. KB (1)		40	40	98	75	63
Ky-31 Tall Fescue (9)		18	20	88	65	48
Ky-31 Tall Fescue (7) + Pennfine Bent-grass (1)		23	18	63	35	35
Average		37	40	91	67	59

* 1X = 1 trip over with traffic machine on each date.
2X = 2 trips over.

**KB = Red Fescue, KB = Kentucky bluegrass.

Table 2. Percent tall fescue in turf seeded with tall fescue alone and in mixtures, mowed at two heights and subjected to moderately heavy (1X) and heavy (2X) traffic. 1968.

Grass (lb/1000 ft.^{2})	Mowing Height 1½ Inches 1X* %	1½ Inches 2X %	2½ Inches 1X %	2½ Inches 2X %	Ave. %
Ky-31 Tall Fescue (3)	75	68	83	84	78
Ky-31 + Pennlawn RF** (2)	70	77	68	75	73
Ky-31 + Windsor KB** (1)	33	30	46	54	41
Ky-31 + Merion KB (1)	37	32	59	62	47
Ky-31 + Com. KB (1)	57	47	68	68	60
Ky-31 + Merion + Com. KB (1)	38	28	66	53	47
Ky-31 Tall Fescue (5)	85	83	98	70	84
Ky-31 + Pennlawn RF (2)	68	73	53	75	68
Ky-31 + Windsor KB (1)	28	25	44	44	35
Ky-31 + Merion KB (1)	40	35	45	48	42
Ky-31 + Com. KB (1)	42	57	52	58	52
Ky-31 + Merion + Com. KB (1)	53	52	66	55	57
Ky-31 Tall Fescue (7)	65	78	93	90	82
Ky-31 + Pennlawn RF (2)	60	77	53	67	64
Ky-31 + Windsor KB (1)	36	43	54	58	48
Ky-31 + Merion KB (1)	35	43	65	63	52
Ky-31 + Com. KB (1)	52	55	73	62	60
Ky-31 + Merion + Com. KB (1)	48	48	63	45	51
Ky-31 Tall Fescue (9)	65	88	92	90	84
Ky-31 Tall Fescue (7) + Penncross Bentgrass (1)	93	93	83	78	87
Average	54	57	66	65	61

* 1X = 1 trip over with traffic machine on each date.
2X = 2 trips over.

**RF = Red Fescue, KB = Kentucky bluegrass.

Table 2. Percent tall fescue in turf seeded with tall fescue alone and in mixtures, mowed at two heights and subjected to moderately heavy (1X) and heavy (2X) traffic. 1956.

Grass (lb/1000 ft.^{2})	Mowing Height				Ave.
	1½ Inches		2½ Inches		
	1X*	2X	1X	2X	
	%	%	%	%	%
Ky-31 Tall Fescue (3)	75	68	83	84	78
Ky-31 + Pennlawn RF** (2)	70	77	68	75	73
Ky-31 + Windsor KB** (1)	33	39	46	54	41
Ky-31 + Merlon KB (1)	37	32	59	62	47
Ky-31 + Com. KB (1)	57	47	58	68	60
Ky-31 + Merlon + Com. KB (1)	38	28	56	53	47
Ky-31 Tall Fescue (5)	85	83	88	70	84
Ky-31 + Pennlawn RF (2)	68	73	58	75	68
Ky-31 + Windsor KB (1)	28	25	44	44	35
Ky-31 + Merlon KB (1)	40	35	45	48	42
Ky-31 + Com. KB (1)	42	57	52	58	52
Ky-31 + Merlon + Com. KB (1)	53	52	66	55	57
Ky-31 Tall Fescue (7)	65	78	93	90	82
Ky-31 + Pennlawn RF (2)	60	77	53	67	64
Ky-31 + Windsor KB (1)	36	43	54	58	48
Ky-31 + Merlon KB (1)	35	43	65	63	52
Ky-31 + Com. KB (1)	32	55	73	62	60
Ky-31 + Merlon + Com. KB (1)	48	48	63	45	51
Ky-31 Tall Fescue (9)	65	88	92	90	84
Ky-31 Tall Fescue (7)	93	93	83	78	87
+ Pennycross Bentgrass (1)					
Average	54	57	66	65	61

* 1X = 1 trip over with traffic machine on each date.
2X = 2 trips over.

**RF = Red Fescue, KB = Kentucky bluegrass.

Table 3. Turf quality ratings of turf with tall fescue seeded alone and in mixtures, mowed at two heights and subjected to moderately heavy (1X) and heavy (2X) traffic. 1968.

Grass	(lb/1000 ft.^{2})	Mowing Height: 1½ Inches 1X	1½ Inches 2X	2½ Inches 1X	2½ Inches 2X	Ave.
Ky-31 Tall Fescue (3)		1.5[1]	1.3	5.8	3.0	2.9
Ky-31 + Pennlawn RF** (2)		1.7	2.3	6.3	4.3	3.7
Ky-31 + Windsor KB** (1)		4.0	4.3	7.7	6.3	5.6
Ky-31 + Merion KB (1)		1.7	2.7	8.0	5.5	4.6
Ky-31 + Com. KB (1)		1.7	2.3	6.3	5.0	3.8
Ky-31 + Merion + Com. KB (1)		2.7	2.8	7.3	4.0	4.2
Ky-31 Tall Fescue (5)		1.0	1.0	5.3	2.3	2.4
Ky-31 + Pennlawn RF (2)		1.7	1.3	5.6	3.3	3.0
Ky-31 + Windsor KB (1)		3.7	3.7	7.7	5.0	5.0
Ky-31 + Merion KB (1)		5.0	5.0	8.3	4.7	5.8
Ky-31 + Com. KB (1)		2.8	1.3	6.7	5.0	4.0
Ky-31 + Merion + Com. KB (1)		4.0	4.3	7.6	5.7	4.9
Ky-31 Tall Fescue (7)		1.3	1.3	6.0	3.3	3.0
Ky-31 + Pennlawn RF (2)		1.0	1.3	6.7	3.7	3.2
Ky-31 + Windsor KB (1)		3.0	4.8	7.0	5.0	5.0
Ky-31 + Merion KB (1)		2.0	4.0	7.0	4.0	3.8
Ky-31 + Com. KB (1)		3.3	3.7	7.0	4.7	4.0
Ky-31 + Merion + Com. KB (1)		2.0	4.3	7.7	5.3	4.5
Ky-31 Tall Fescue (9)		3.3	2.0	6.3	5.0	3.8
Ky-31 Tall Fescue (7) + Penncross Bentgrass (1)		1.3	1.0	3.7	3.0	2.3
Average		2.2	2.5	6.7	4.4	4.0

* 1X = 1 trip over with traffic machine on each date.
2X = 2 trips over.

**RF = Red Fescue, KB = Kentucky bluegrass.

[1]Rating Scale: 10 = Best.

Table 3. Turf quality ratings of turf with tall fescue seeded alone and in mixtures, mowed at two heights and subjected to moderately heavy (1X) and heavy (2X) traffic. 1968.

Grass (lb/1000 ft.^{2})	Mowing Height				
	1" Inches		2½ Inches		Ave.
	1X	2X	1X	2X	
Ky-31 Tall Fescue (3)	1.5[1]	1.3	5.8	3.0	2.9
Ky-31 + Pennlawn RF** (2)	1.7	2.3	6.3	4.3	3.7
Ky-31 + Windsor KB** (1)	4.0	4.3	7.7	6.3	5.6
Ky-31 + Merlon KB (1)	1.7	2.7	8.0	5.3	4.8
Ky-31 + Com. KB (1)	1.7	2.3	6.3	5.0	3.8
Ky-31 + Merlon + Com. KB (1)	2.7	2.8	7.3	4.0	4.2
Ky-31 Tall Fescue (5)	1.0	1.0	5.3	2.3	2.4
Ky-31 + Pennlawn RF (2)	1.7	1.3	5.6	3.3	3.0
Ky-31 + Windsor KB (1)	3.7	3.7	7.7	5.0	5.0
Ky-31 + Merlon KB (1)	5.0	5.0	8.3	4.7	5.8
Ky-31 + Com. KB (1)	2.8	1.3	6.7	5.0	4.0
Ky-31 + Merlon + Com. KB (1)	4.0	4.3	7.6	5.7	4.9
Ky-31 Tall Fescue (7)	1.3	1.3	6.0	3.3	3.0
Ky-31 + Pennlawn RF (2)	1.0	1.3	6.7	3.7	3.2
Ky-31 + Windsor KB (1)	3.0	4.8	7.0	5.0	5.0
Ky-31 + Merlon KB (1)	2.0	4.0	7.0	4.0	3.8
Ky-31 + Com. KB (1)	3.3	3.7	7.0	4.7	4.0
Ky-31 + Merlon + Com. KB (1)	2.0	4.3	7.7	5.3	4.5
Ky-31 Tall Fescue (9)	3.3	2.0	6.3	5.0	3.8
Ky-31 Tall Fescue (7) + Pennycross Bentgrass (1)	1.3	1.0	3.7	3.0	2.3
Average	2.2	2.5	6.7	4.4	4.0

* 1X = 1 trip over with traffic machine on each date.
2X = 2 trips over.

**RF = Red Fescue, KB = Kentucky bluegrass.

[1]Rating Scale: 10 = Best.

Effectiveness and Residual Properties of Several Herbicides Used in Turfgrass Areas

E. E. Deal
Department of Agronomy

Purpose and Objectives

Herbicides are being used extensively on some turf areas in Maryland to control annual and perennial weeds. Little is known about the degree of accumulation of these materials in the soil and what effects they have on turfgrasses. The purpose of this study was to determine the effectiveness of new herbicides for use on turf and to study the effects of repeated applications and high rates of these materials on the turfgrasses.

Procedures

Experiment A (Crabgrass and Goosegrass Control). Turfgrass areas previously infested with crabgrass and goosegrass were selected at the University of Maryland and Ocean City Golf Courses for experimental plots. Commercially available herbicides and promising new ones for preemergence control of these weeds were applied in April 1968 at several rates and in all available formulations (Table 1). Weed control and effect of the herbicides on established stands of turf were assessed by quadrate counts or visual ratings as appropriate.

Experiment B (Herbicide Residues). Herbicides listed in Table 2 were applied at the recommended or suggested rate on the same turfgrass plot yearly in an effort to determine if they have any accumulative effects. Kentucky bluegrass, red fescue turf which was planted in September 1965 at the University of Maryland Plant Research farm, has been treated with herbicides in this manner for up to three successive years. Quadrate counts were made for weed control determinations, and visual estimates were made of turf quality, changes in turf composition, and turf injury caused by the herbicides.

Effectiveness and Residual Properties of Several Herbicides Used in Turfgrass Areas

R. E. Deal
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Experiment A (Crabgrass and Goosegrass Control). Turfgrass areas previously infested with crabgrass and goosegrass were selected at the University of Maryland and Ocean City Golf Courses for experimental plots. Commercially available herbicides and promising new ones for preemergence control of these weeds were applied in April 1958 at several rates and in all available formulations (Table 1). Weed control and effect of the herbicides on established stands of turf were assessed by quadrats counts or visual ratings as appropriate.

Experiment B (Herbicide Residues). Herbicides listed in Table 2 were applied at the recommended or suggested rate on the same turfgrass plot yearly in an effort to determine if they have any accumulative effects. Kentucky bluegrass, red fescue turf which was planted in September 1955 at the University of Maryland Plant Research Farm, has been treated with herbicides in this manner for up to three successive years. Quadrats counts were made for weed control determinations, and visual ratings were made of turf quality, change in turf composition, and turf injury caused by the herbicides.

Experiment C (Annual Bluegrass Control). Several preemergence herbicides were applied at different rates and in different formulations on three dates (at about 2-week intervals) in an area previously infested with annual bluegrass on a fairway of the University of Maryland Golf Course in the fall of 1968. Annual bluegrass control and effects of the herbicides, if any, on the established turf will be evaluated in the spring of 1969.

Results

Experiment A (Crabgrass and Goosegras Control). A list of herbicides, the formulations of each, and the rates of application can be found in Table 1. Of the new preemergence herbicides being developed and evaluated, nitralin (Planavin) is the only one which shows much promise. Control of crabgrass in these and other studies have been fairly consistent but slightly lower than desirable. The margin of safety with over-applications has not been adequately determined.

DCPA (Dacthal), bensulide (Betasan, Pre-San), and siduron (Tupersan) continue to be about the most effective, safest, and most economical of the commercially available herbicides, although siduron gives erratic control at times. None of the materials used in 1968 caused any significant damage to the turf.

Experiment B (Herbicide Residues). Herbicides, rates and formulations are listed in Table 2. Three yearly applications of bandane g, D-263 g, DCPA g and wp, terbutol (Azak) wp and tricalcium arsenate g have greatly reduced the amount of red fescue in the turf. Nitralin wp after two and three applications has also reduced the red fescue content.

After a prolonged drought period in April, 1968, plots which had received two applications of D-263 g, two of terbutol g and one or two of terbutol wp showed a high degree of wilting. Grass in plots which had

received two applications of bandane and tricalcium arsenate had significantly less new growth in them than other plots. These same plots also had fewer broadleaf weeds in them.

In October 1968, following two and three applications of each, the following herbicides had controlled more than 95% of the crabgrass; bandane g, bensulide ec, D-263 g, DCPA g and wp, and tricalcium arsenate g. Bensulide g gave 100% crabgrass control after three applications and 89% after 2. Terbutol wp and nitralin g gave good control (84-95%) after two and three applications.

Experiment C (Annual Bluegrass Control). Plots were established in the fall of 1968 and results will not be available until 1969.

Summary

Herbicides currently recommended by the University for preemergence crabgrass control (DCPA, bensulide, and siduron) continue to be the most effective, economical, and the safest to the turf. One new herbicide, nitralin, offered promise for large scale use because of the low rate required. Other herbicides which have been available commercially for several years continue to be somewhat erratic in their control or cause too much turf injury at times to justify adding them to the list of recommended materials. Results of studies made to control annual bluegrass are not available at this time.

Each phase of this study is being continued.

Table 1. Preemergence crabgrass control studies with various herbicides applied at different rates and formulations at Ocean City and University of Maryland Golf Courses.

Herbicide, Formulation[1]	Rate/A Lbs.	Crabgrass Control[2] Ocean City Golf Course %	Crabgrass Control[2] U. of Md. Golf Course %	Goosegrass Control U. of Md. Golf Course %
Bandane g.	35	84	68	69
Tricalcium Arsenate, g.	375	99	70	31
Benefin, g.	1½	37	40	9
Benefin, g.	3	77	62	48
DCPA, g.	11	97	72	66
DCPA, wp.	11	100	87	69
Bensulide, g.	10	57	58	5
Bensulide, g.	15	84	76	36
Bensulide, ec.	10	85	72	19
Bensulide, ec.	15	97	72	55
Terbutol, g.	10	70	44	73
Terbutol, wp.	10	82	44	60
Siduron, g.	10	83	31	0
Siduron, g.	15	90	56	6
Siduron, wp.	10	91	30	13
Siduron, wp.	15	100	59	40
Siduron, wdl	10	98	29	19
Siduron, wdl	15	100	79	46
R-3552, wp.	2	1	2	3
R-3552, wp.	4	0	1	12
R-3552, wp.	6	1	1	0
Nitralin, g.	1½	83	41	9
Nitralin, g.	3	100	44	24
Nitralin, g.	4½	-	41	32
Nitralin, wp.	1½	73	41	2
Nitralin, wp.	3	94	69	5
Nitralin, wp.	4½	98	79	23
Untreated Check		1	4	3

[1]g = granular, ec. = emulsifiable concentrate, wp= wettable powder, wdl = water dispersible liquid.

[2]Quadrate counts --
Percent of 72 quadrates (6 x 6")/plot with no crabgrass plants.

Table 1. Preemergence crabgrass control studies with various herbicides applied at different rates and formulations at Ocean City and University of Maryland Golf Courses.

Herbicide, Formulation[1]	Rate/A lbs.	Crabgrass Control[2] Ocean City Golf Course %	U. of Md. Golf Course %	Goosegrass Control U. of Md. Golf Course %
Bandane G.	35	84	68	59
Trioxicium				
Arsenate, G.	37½	99	70	31
Benefin, G.	1½	37	46	9
Benefin, G.	3	77	52	48
DCPA, G.	11	97	72	66
DCPA, wp.	11	100	87	89
Bensulide, G.	10	57	58	5
Bensulide, G.	15	84	76	35
Bensulide, ec.	10	85	72	10
Bensulide, ec.	15	97	72	55
Terbutol, G.	10	70	44	73
Terbutol, wp.	10	82	44	60
Siduron, G.	10	83	31	0
Siduron, G.	15	90	56	6
Siduron, wp.	10	91	30	13
Siduron, wp.	15	100	58	40
Siduron, wdl	10	98	29	16
Siduron, wdl	15	100	79	46
D-3552, wp.	2	1	2	3
D-3552, wp.	4	0	1	12
D-3552, wp.	6	1	1	0
Nitralin, G.	1½	83	41	9
Nitralin, G.	3	100	44	24
Nitralin, G.	4½	-	41	32
Nitralin, wp.	1½	73	41	2
Nitralin, wp.	3	94	80	5
Nitralin, wp.	4½	98	79	23
Untreated Check		1	4	3

[1] G = granular, ec. = emulsifiable concentrate, wp= wettable powder, wdl = water dispersible liquid.

[2] Quadrate counts -- Percent of 72 quadrates (6 x 6")\plot with no crabgrass plants.

Table 2. Turf response and crabgrass control with preemergence herbicides applied yearly to plots at the University of Maryland Plant Research Farm. 1968 Results.

Herbicide, Formulation[1]	Rate/A lbs.	Turf Wilting (4/68)	Growth Rating (4/68)	Turf Quality (12/68)	% Turf Cover (12/68)	% Red Fescue (12/68)	% Crabgrass Control (10/68)
			Applied 1966, 1967, 1968				
Bandane, g.	35	9.8[2]	6.5[2]	7.8[2]	98	3	100[3]
Benefin, g.	1½	10.0	10.3	6.0	82	23	66
Benefin, ec.	1½	10.0	10.0	4.5	58	30	33
Bensulide, g.	15	8.8	8.0	7.8	93	24	100
Bensulide, ec.	15	9.8	9.3	6.0	84	24	100
D-263, g.	8	7.0	8.5	6.3	90	13	100
D-263, ec.	8	10.0	10.3	5.5	70	21	33
DCPA, g.	11	10.0	10.0	6.5	86	13	100
DCPA, wp.	11	10.0	9.5	6.3	85	10	100
TOK-3, g.	8	10.0	10.0	5.0	69	16	33
Terbutol, g.	10	7.8	9.0	5.5	78	31	72
Terbutol, wp.	10	7.8	9.0	6.3	86	29	89
Nitralin, g.	1½	10.0	11.5	5.3	66	33	84
Nitralin, wp.	1½	10.0	11.3	3.8	51	29	36
Siduron, g.	10	10.0	10.0	5.3	75	25	53
Siduron, wp.	10	10.0	10.0	6.8	86	25	78
Tricalcium arsenate, g.	376	10.0	6.3	4.3	61	10	100
Check (untreated)		9.9	10.1	3.9	40	23	2
			Applied 1967, 1968				
Bandane, g.	35	10.0	7.8	7.8	97	5	100
Bensulide, g.	15	10.0	10.3	6.8	91	25	89
Bensulide, ec.	15	10.0	10.0	6.3	86	29	97
D-263, g.	8	9.3	9.8	5.3	80	19	100
D-263, ec.	8	10.0	10.3	4.3	56	29	35
Terbutol, g.	10	9.5	9.8	4.8	64	29	65
Terbutol, wp.	10	7.3	8.5	5.8	76	28	89
Nitralin, g.	1½	10.0	10.3	7.0	90	26	88
Nitralin, wp.	1½	10.0	10.3	5.5	66	21	53

[1]Formulation: g= granular, ec= emulsifiable concentrate, wp= wettable powder.

[2]Rating scale: 10 = normal or best, 1 = most wilting or poorest.

[3]Quadrate counts -- Percent of 72 quadrates (6 x 6")/plot with no crabgrass plants.

Table 2. Turf response and crabgrass control with preemergence herbicides applied yearly to plots at the University of Maryland Plant Research Farm. 1968 Results.

Herbicide, Formulation[1]	Rate/A lbs.	Wilting (4/66)	Rating (4/68)	Turf Growth Quality (12/66)	Turf Cover (12/68)	% Turf Fescue	% Red Fescue	% Crabgrass Control (10/68)
Applied 1966, 1967, 1968								
Bandane, E.	35	9.8[2]	6.5[2]	7.8[2]		98	3	100[3]
Benefin, E.	1½	10.0	10.3	6.0		82	23	66
Benefin, ec.	1½	10.0	10.0	4.5		58	30	33
Benzulide, E.	15	9.8	8.0	7.8		93	24	100
Benzulide, ec.	15	9.8	9.3	6.0		84	24	100
D-263, E.	8	7.0	8.5	6.3		90	13	100
D-263, ec.	8	10.0	10.3	5.5		70	21	33
DCPA, E.	11	10.0	10.0	6.5		96	13	100
DCPA, wp.	11	10.0	9.5	6.3		85	10	100
TOK-3, E.	8	10.0	10.0	5.0		69	16	33
Terbutol, E.	10	7.8	9.0	5.5		78	31	72
Terbutol, wp.	10	7.8	9.0	6.3		86	29	89
Nitralin, E.	1½	10.0	11.5	5.3		66	33	84
Nitralin, wp.	1½	10.0	11.3	3.8		51	29	36
Stauron, E.	10	10.0	10.0	5.3		75	25	53
Stauron, wp.	10	10.0	10.0	6.8		96	25	78
Trifluralin granulars, E.	375	10.0	6.3	4.3		61	10	100
Check (untreated)		9.9	10.1	3.9		40	23	2
Applied 1967, 1968								
Bandane, E.	35	10.0	7.8	7.8		97	5	100
Benzulide, E.	15	10.0	10.3	6.8		91	25	89
Benzulide, ec.	15	10.0	10.0	6.3		86	29	97
D-263, E.	8	9.3	9.8	5.3		80	19	100
D-263, ec.	8	10.0	10.3	4.3		56	29	35
Terbutol, E.	10	9.5	9.8	4.8		64	29	65
Terbutol, wp.	10	7.3	8.5	5.8		76	28	89
Nitralin, E.	1½	10.0	10.3	7.0		90	26	88
Nitralin, wp.	1½	10.0	10.3	5.5		66	21	53

[1]Formulation: E= granular, ec= emulsifiable concentrate, wp= wettable powder.

[2]Rating scale: 10 = normal or best, 1 = most wilting or poorest.

[3]Quadrate count -- Percent of 72 quadrates (6 x 6")/plot with no crabgrass plants.

Factors Affecting Turf Quality and Rate of Production of Bluegrass-Red Fescue Sod

E. E. Deal
Department of Agronomy

Purpose and Objectives

Sod production in Maryland has become a multi-million dollar industry in recent years. In 1968 an estimated 8,000 acres of sod valued at $9.7 million were sold in the state. The objectives of this experiment were to find ways of reducing the time required to grow sod to the stage of maturity where it can be severed and moved without damaging its appearance or quality. Specific objectives were to determine whether seeding rate, mowing height or soil fertility had the greatest effect on rate of maturity; determine the effects of these practices on food storage in crowns, roots, and rhizomes of the plants; and attempt to relate plant density and underground growth to sod development.

Procedures

A seed mixture containing 40% Merion Kentucky bluegrass, 40% common Kentucky bluegrass, and 20% Pennlawn red fescue by weight was seeded in the fall of 1965 at two rates--50 and 100 lbs. per acre. In the spring of 1966 mowing heights of 1, 2, and 3 inches were established on these plots and maintained throughout the experiment. At the same time two nitrogen fertilizer levels were started. These consisted of applying 132 and 264 lbs. N per acre per year in the form of urea in three equal applications (March, September, and October).

Data recorded included periodic visual ratings of overall turf quality and weed infestation. Samples of sod were harvested at approximately 3-month intervals beginning about 6 months after seeding and continuing until the

Factors Affecting Turf Quality and Rate of Production of Bluegrass-Red Fescue Sod

B. E. Deal
Department of Agronomy

Purpose and Objectives

Sod production in Maryland has become a multi-million dollar industry in recent years. In 1958 an estimated 8,000 acres of sod valued at $9.7 million were sold in the state. The objectives of this experiment were to find ways of reducing the time required to grow sod to the stage of maturity where it can be severed and moved without damaging its appearance or quality. Specific objectives were to determine whether seeding rate, mowing height or soil fertility had the greatest effect on rate of maturity; determine the effects of these practices on food storage in crowns, roots, and rhizomes of the plants; and attempt to relate plant density and undergrowth growth to sod development.

Procedures

A seed mixture containing 60% Merion Kentucky bluegrass, 40% common Kentucky bluegrass, and 20% Pennlawn red fescue by weight was seeded in the fall of 1955 at two rates--50 and 100 lbs. per acre. In the spring of 1956 mowing heights of 1, 2, and 3 inches were established on these plots and maintained throughout the experiment. At the same time two nitrogen fertilizer levels were started. These consisted of applying 132 and 264 lbs. N per acre per year in the form of urea in three equal applications (March, September, and October).

Data recorded included periodic visual ratings of overall turf quality and weed infestation. Samples of sod were harvested at approximately 3-month intervals beginning about 5 months after seeding and continuing until the

seed was almost 2 years old. At each harvest data were taken on sod quality, resistance to tearing when rolled and handled, plant population, root development, and plant size.

Results

During the first few months after seeding there were considerably more grass plants, fewer weeds, and the individual grass plants were smaller where a 100-lb. seeding rate was used as compared to a 50-lb. rate. A herbicide application to all areas eliminated the weeds when the turf was 7 months old, and from that time on there was little difference in turf density or rollability of the sod. The individual plant size and the amount of rhizome development was greatest when the low seeding rate was used.

Nitrogen levels used in this study have not produced any striking differences in plant size or density, rollability or rhizome development. Turf which received 132 lbs. N per year had significantly greater resistance to tearing when handled than that which received 264 lbs. During the first few weeks after applications were made, plots which received the higher rate were slightly greener but this was a short term response.

The number of plants per unit area decreased gradually at the 2-and 3-inch mowing heights from the time mowing heights were started but have increased slightly at the 1-inch height. Turf density has remained about the same at the two taller heights but has been very poor at times at the 1-inch height. Seasonal variations have caused a great deal of fluctuation in plant numbers, but the relative differences have been about the same. Sod strength has been greatest at the tallest mowing height. Rhizome growth has increased with age of the sod as expected, but at times the greatest amount of rhizomes has been in turf cut at 2 inches rather than at 1 or 3 inches.

Summary

There was an early short-term advantage of using a 100-lb. seeding rate over 50 lbs., but by the time sod was ready to harvest it was about equal or in some instances better at the low seeding rate. Three applications of nitrogen per year giving a total of 132 or 264 lbs. per acre gave about the same results, indicating that there was no advantage of using high rates of nitrogen on Kentucky bluegrass-red fescue turf. A 2-inch mowing height appears to be best for this type of turf.

Evaluation of Sod-Seeded Species to Supplement Permanent Forage Stands

A. M. Decker
Department of Agronomy

Purpose and Objectives

The production of many of our permanent forage species can be improved with sod-seeding. For example, summer as well as total forage production of Kentucky bluegrass has been increased with sod-seeded trefoil and crownvetch. The growing season of bermudagrass, which has good summer growth, has been extended with sod-seeded, cool-season annuals.

The purpose of this phase of the project was to determine if perennial cool-season species could be as successfully sod-seeded into Midland bermudagrass as cool-season annuals. The objectives of the study were: (1) determine total seasonal distribution of forage yields of Midland plus three sod-seeded cool-season annuals, (2) compare the management and stand persistence problems of sod-seeded annuals and perennials.

Procedure

A uniform stand of Midland bermudagrass was sod-seeded, in the fall of 1965, with rye, rye-wheat, rye-wheat-hairy vetch, rye-wheat-Penngift crownvetch, Penngift crownvetch, Chemung crownvetch, Ky-31 tall fescue, and Potomac orchardgrass. In the fall of 1966 and 1967 seeding of the annuals was repeated. In addition, the crownvetch was reseeded in 1966 because of poor establishment in 1965. Where only grasses were sod-seeded, the plots were fertilized in early spring with 50 lbs N per acre. Where a legume was seeded with the grasses, no N was used in the spring. During the summer period, the Midland was fertilized with 200, 400, and 600 lbs. of N per acre

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Procedure

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in four equal split applications. The experimental design was a completely randomized block with four replications. Four harvests were made in 1966 with five in 1967 and 1968.

Results

Total dry matter production for the three year period is given in Table 1. In 1966, yields were very low because of an extended summer drought. Approximately two thirds of the yield was from the sod-seeded species in this first year. In 1967, with good rainfall, yields were higher. In this year, the perennial grasses (Ky-31 and Potomac) were significantly less productive than either the rye or rye-wheat, but were about equal to the rye-wheat-hairy vetch mixture. The two perennials added only about a half ton more forage than the Midland alone, which had a total of 50 lbs less N per acre. In 1968, the results were similar except yields were generally higher. In all three years there was a significant increase in yield between the 200-and 400-lbs N per acre applications (Table 1). There was also an increase between 400 and 600 lbs N during the first two years but not in 1968.

The crownvetch stands were good enough in 1968 for yields to be made. The three crownvetch treatments were similar and produced the least amount of forage when compared to the other crops included in the experiment. They were approximately 1.5 tons lower than the hairy vetch treatment.

Summary

1. Cool-season perennials can be successfully sod-seeded into a Midland sod.
2. The sod-seeded perennials were slightly less productive than the sod-seeded annuals.

3. Forage production leveled off between applications of 400 and 600 lbs N per acre.

4. Although crownvetch was successfully established, production was not as high as other species.

5. Both perennial grasses thinned the stand and delayed early growth of the Midland more than the annuals.

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4. Although crownvetch was successfully established, production was not as high as other species.

5. Both perennial grasses thinned the stand and delayed early growth of the Midland more than the annuals.

Table 1. Tons of dry matter produced from Midland plus sod-seeded species at one or more nitrogen levels.

Sod-seeded species	Nitrogen applied: Sod-seeded species lbs/A	Nitrogen applied: Midland lbs/A	Total Forage Production: 1966 T/A	1967 T/A	1968 T/A	Av. T/A
None	0	400	1.65	4.16	5.62	3.81
Rye	50	400	3.28	6.10	7.49	5.62
Rye + Wheat	50	200	2.28	3.66	5.12	3.69
Rye + Wheat	50	400	2.66	5.98	7.52	5.38
Rye + Wheat	50	600	3.05	7.30	7.65	6.00
Rye + Wheat + H. Vetch	0	200	3.14	4.72	5.74	4.53
Rye + Wheat + Crownvetch	0	200	2.44	----[1]	4.32	3.38
Penngift Crownvetch	0	200	.35	----[1]	4.24	2.30
Chemung Crownvetch	0	200	.38	----[1]	4.34	2.36
Ky-31 Tall Fescue	50	400	3.28	4.70	6.10	4.69
Potomac Orchard	50	400	2.93	4.56	6.06	4.52
	Average		2.31	4.60	5.84	4.25

[1]No nitrogen applied and no yields determined in 1967, while allowing the crownvetch to establish.

Table 1. Tons of dry matter produced from Midland plus sod-seeded species at one or more nitrogen levels.

Sod-seeded species	Nitrogen applied: Sod-seeded species lbs/A	Midland lbs/A	Total Forage Production: 1955 T/A	1957 T/A	1958 T/A	Av. T/A
None	0	400	1.65	4.16	5.62	3.81
Rye	50	400	3.28	6.10	7.40	5.62
Rye + Wheat	50	200	2.28	3.66	5.12	3.69
Rye + Wheat	50	400	2.65	5.98	7.52	5.38
Rye + Wheat	50	600	3.05	7.30	7.65	6.00
Rye + Wheat + H. Vetch	0	200	3.14	4.72	5.74	4.53
Rye + Wheat + Crownvetch	0	200	2.44	----[1]	4.32	3.38
Pennglit Crownvetch	0	200	.35	----[1]	4.24	2.30
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Plant Environmental Studies

A. M. Decker
Department of Agronomy

Purpose and Objectives

The experiment was designed to study the effects of environment on the growth and development of forage grasses. It is difficult to relate plant responses to environmental factors such as temperature, light, and moisture simply because growth and development of plants are complicated summations of many processes, each of which is influenced by the environment to varying degrees.

Research projects have been conducted to study plants and their environment under "natural" conditions where no control is imposed; the variables are merely measured. Other projects have been designed to study the effects of specific environmental factors in growth chambers where many characteristics are rigidly controlled.

All of these studies have contributed to our understanding of environment and plants, but much more needs to be known. There is a need to more accurately define the relationship between the growth and development of plants grown in rigidly controlled conditions and those grown in the field under "natural" environments. The objectives of this study were, then, to study the response of cool-season grasses and legumes grown in the field where soil temperatures during the growing season were controlled or modified.

Procedure

Potomac and S-37 orchardgrass plus Climax timothy were grown in solid stands in field plots for three years with soil temperatures at ambient, 10C, 21C, and 32C. During this past season, clonal plant material similar to the three grasses were also grown in pots completely buried in these plots so that a uniform soil level existed; only the root systems were

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Potomac and S-37 orchardgrass plus Climax timothy were grown in soild stands in field plots for three years with soil temperatures at ambient, 10C, 21C, and 32C. During this past season, clonal plant material similar to the three grasses were also grown in pots completely buried in these plots so that a uniform soil level existed; only the root systems were

separated. Weekly tiller measurements were made on these potted plants. After each five-week period, the plants were harvested and dry matter yields determined. Dry matter yields of the solid seedings, in which the plants were placed, were also determined at this time. Red Clover plants (a long-lived strain selected from Chesapeake and Dollard, a northern unadapted strain), were also grown in pots buried in the Climax plots. Dry matter yields of the clover were determined on the same dates as the grasses. At the end of the growing season, root and crown weights were determined for all plants grown in the pots in addition to a square foot area of sod in each solid-seeded plot. Temperature above and below the soil surface was monitored.

Results

The number of total live tillers per 0.05 square meter at each harvest date is shown in Table 1. It can be seen that S-37 had the highest tiller number followed by Potomac and then Climax. Highest tiller numbers were associated with the 10C plots with 32C having the lowest number. The 21C and ambient plots were intermediate and similar. The most dramatic temperature effect was with Climax where a substantial reduction occurred. In order to study this more closely, new tiller development was followed with Climax. Again, the cooler plots had more new tiller development. However, the reduction in new tiller development was as great at ambient as at 32C.

Dry matter production in grams per plot is given in Table 2. Highest overall production was from Potomac and lowest from Climax. Dry matter yields followed very closely the pattern of tiller numbers. This is not surprising, since top growth is the result of tiller growth.

In order to study the behavior of individual plants within a forage stand, clonal material representing the three grass varieties were placed in the solid stands where weekly measurements were made. Summarization of these data is not complete, but total forage yields and weight of crown and roots at the end of the season are given in Table 4. In general, dry matter production followed the pattern of the solid stand. However, where growth of the solid stand was greatest, the growth of individual plants was reduced. This is most striking, if one compares the performance of Potomac and Climax at the two temperature extremes. As expected, crown and root growth was affected even more by soil temperatures than was top growth. At the beginning of the season, there was a total of six clonal plants in each treatment. Soil temperature had a marked effect on plant survival from 100% down to only 33%. Greatest plant loss was experienced with S-37.

In addition to the grass clones, Red Clover plants were placed in the Climax plots where similar data were collected. We were primarily interested in seeing what effect temperature had on survival of a strain unadapted to Maryland (Dollard) and one selected for longevity under Maryland conditions. As with the grasses, dry matter yield was influenced by temperature (Table 4). However, 21C rather than 10C was the highest. At 10C, there was 100% survival of both clovers, but at 32C, none of the Dollard survived. Whenever temperatures were increased over the 10C level, plant losses of Dollard were significantly higher than for the Maryland selection.

Summary

1. Soil temperature affected the top growth, crown growth, and root growth of the three grasses and two clovers studied.
2. Climax timothy and S-37 orchardgrass were more sensitive to soil temperature than Potomac.
3. Plant survival was highest for all species at 10C and lowest at 32C.
4. Top growth of the grasses was highest at 10C and for the clovers at 21C.

Table 1. Total live tillers per 0.05 square meters at harvest time, 1968.

Soil Temperature	Species	Date of Count 5-7	6-12	7-18	8-21	9-25	Av.
Ambient	Potomac	167	134	105	91	130	125
	S-37	199	150	111	96	127	137
	Climax	203	133	100	112	110	132
	Av.	189	139	105	100	122	131
10C	Potomac	177	131	91	148	155	140
	S-37	207	130	116	179	196	166
	Climax	212	128	118	191	205	171
	Av.	199	130	108	173	185	159
21C	Potomac	186	123	122	109	138	136
	S-37	187	131	123	90	142	135
	Climax	154	131	109	89	122	121
	Av.	175	129	118	96	134	130
32C	Potomac	157	111	125	118	126	127
	S-37	221	110	139	77	106	131
	Climax	147	43	88	55	54	77
	Av.	175	88	117	83	95	112
Average:	Potomac	172	125	111	116	137	132
	S-37	204	130	122	110	143	142
	Climax	179	109	104	112	123	125
	Av.	184	122	112	113	134	

Table 1a. New tillers on Climax per 0.05 meters one week after harvest, 1968.

Soil Temperature	Tillers	Date of Count 5-16	6-19	7-24	8-28	10-1
Ambient	New	24.6	24.0	10.0	15.7	1.7
	accum.		48.6	58.6	74.3	76.0
10C	New	12.7	41.3	23.7	22.7	3.0
	accum.		54.0	77.7	100.4	103.4
21C	New	50.3	11.7	32.0	14.7	4.0
	accum.		62.0	94.0	108.7	112.7
32C	New	38.0	10.3	13.3	8.0	3.0
	accum.		48.3	61.6	69.6	72.6
Average:	New	31.4	21.8	19.7	15.3	2.9
	accum.		53.2	73.0	88.2	91.1

Table 1a. New tillers on Climax per 0.05 meters one week after harvest, 1958.

Soil Temperature	Tillers	Date of Count 5-16	6-19	7-24	8-29	10-1
Ambient	New	24.6	24.0	10.0	15.7	1.7
	accum.		48.6	58.6	74.3	76.0
10C	New	12.7	41.3	23.7	22.7	3.0
	accum.		54.0	77.7	100.4	103.4
21C	New	50.3	11.7	32.0	14.7	4.0
	accum.		62.0	94.0	108.7	112.7
32C	New	38.0	10.3	13.3	8.0	3.0
	accum.		48.3	61.6	69.6	72.6
Average:	New	31.4	21.8	19.7	15.3	2.9
	accum.		53.2	73.0	88.2	91.1

Table 2. Dry matter production in grams per plot during growing season.

Soil Temperature	Species	Harvest Dates 1968 5-7	6-11	7-17	8-21	9-25	Total
		grams					
Ambient	Potomac	2.79	2.21	1.90	1.01	.71	8.62
	S-37	2.17	2.37	1.91	.59	.36	7.40
	Climax	2.54	2.11	.74	.86	.51	6.76
	Av.	2.50	2.23	1.52	.82	.53	7.60
10C	Potomac	2.50	2.31	2.33	1.26	1.18	9.58
	S-37	2.05	2.67	2.17	1.27	1.12	9.28
	Climax	2.53	2.42	1.37	.98	.87	8.17
	Av.	2.39	2.48	1.96	1.17	1.06	9.06
21C	Potomac	2.79	1.05	2.31	1.37	.94	8.46
	S-37	2.12	1.30	2.08	1.20	.73	7.43
	Climax	2.42	.88	2.34	.69	.90	7.23
	Av.	2.44	1.08	2.24	1.09	.86	7.71
32C	Potomac	3.24	.88	1.97	.56	.52	7.17
	S-37	2.40	.86	1.54	.50	.33	5.63
	Climax	2.47	.13	.80	.23	.24	3.87
	Av.	2.70	.62	1.44	.43	.36	5.55
Average:	Potomac	2.83	1.61	2.12	1.05	.83	8.44
	S-37	2.18	1.80	1.92	.89	.63	7.42
	Climax	2.49	1.38	1.31	.69	.63	6.50
	Av.	2.50	1.60	1.79	.87	.70	7.46

Table 3. Total seasonal dry matter production and weight of crown and roots at end of season for clonal material in solid seeding (two plants per plot) 1968.

Soil Temperature	Variety	Forage Dry Matter per plant (g)	Crown and root in weight per plant at end of season			Plant Survival (%)
			Crown (.01g)	Root (.01g)	Total (.01g)	
Ambient	Potomac	4.87	41.7	52.0	93.7	83
	S-37	6.00	41.1	51.4	92.5	67
	Climax	4.09	81.1	91.0	172.1	100
	Av.	4.96	54.6	64.8	119.4	83
10C	Potomac	5.53	117.2	196.4	313.6	100
	S-37	8.87	300.3	282.1	582.4	100
	Climax	7.35	230.1	311.8	541.9	100
	Av.	7.03	215.9	263.4	479.3	100
21C	Potomac	7.36	97.8	218.0	315.8	100
	S-37	8.30	118.3	122.3	240.6	67
	Climax	7.42	137.1	116.8	253.9	100
	Av.	7.70	117.7	152.4	270.1	89
32C	Potomac	1.66	9.5	15.6	25.1	50
	S-37	3.05	10.6	12.5	23.1	33
	Climax	3.83	81.1	94.5	175.6	100
	Av.	2.86	33.7	40.9	74.6	61
Averages:	Potomac	4.85	66.6	120.5	187.1	83
	S-37	6.56	117.6	117.1	234.7	67
	Climax	5.67	132.4	153.5	285.9	100
	Av.	5.69	105.5	130.4	235.9	83

Table 3. Total seasonal dry matter production and weight of crown and roots at end of season for clonal material in solid seeding (two plants per plot) 1966.

Soil Temperature	Variety	Forage Dry Matter per plant (g)	Crown and root in weight per plant at end of season Crown (.01g)	Root (.01g)	Total (.01g)	Plant Survival (%)
Ambient	Potomac	4.87	41.7	32.0	73.7	83
	S-37	6.00	41.1	51.4	92.5	67
	Climax	4.09	81.1	91.0	172.1	100
	Av.	4.96	54.6	58.8	119.4	83
10C	Potomac	5.53	117.2	196.4	313.6	100
	S-37	8.87	300.3	282.1	582.4	100
	Climax	7.35	230.1	311.8	541.9	100
	Av.	7.03	215.9	263.4	479.3	100
21C	Potomac	7.36	97.8	218.0	315.8	100
	S-37	8.30	118.3	122.3	240.6	67
	Climax	7.42	137.1	116.8	253.9	100
	Av.	7.70	117.7	152.4	270.1	86
32C	Potomac	1.65	9.5	15.6	25.1	50
	S-37	3.05	10.6	12.5	23.1	33
	Climax	3.03	81.1	94.5	175.6	100
	Av.	2.86	33.7	40.9	74.6	61
Averages:	Potomac	4.85	66.6	120.5	187.1	83
	S-37	6.56	117.6	117.1	234.7	67
	Climax	5.67	132.4	153.5	285.9	100
	Av.	5.69	105.5	130.4	235.9	83

Table 4. Total seasonal dry matter production and weight of crown and roots at end of season, 1968.

Soil Temperature	Variety	Forage Dry Matter per plant (g)	Crown and root weight per plant at end of season			Plant Survival (%)
			Crown (.01g)	Root (.01g)	Total (.01)	
Ambient	Md. Sel.	17.62	116.4	252.3	368.7	66
	Dollard	17.82	48.0	70.7	118.7	33
	Av.	17.71	82.2	161.5	243.7	50
10C	Md. Sel.	10.69	126.0	274.5	400.5	100
	Dollard	11.55	145.0	333.7	478.7	100
	Av.	11.46	135.5	304.1	439.6	100
21C	Md. Sel.	21.00	139.0	271.9	410.9	100
	Dollard	12.43	96.5	229.4	325.9	66
	Av.	16.71	117.8	250.6	368.4	83
32C	Md. Sel.	10.39	59.1	58.9	118.0	66
	Dollard	2.66	----	----	-----	0
	Av.	6.52	29.6	29.4	59.0	33
Averages:	Md. Sel.	15.09	110.1	214.4	324.5	83
	Dollard	11.12	72.4	158.4	230.8	50
	Av.	13.11	91.2	186.4	277.6	66

Table 4. Total seasonal dry matter production and weight of crown and roots at end of season, 1958.

Soil Temperature	Variety	Storage Dry matter per plant (g)	Crown and root weight per plant at end of season			Plant Survival (%)
			Crown (.01g)	Root (.01g)	Total (.01)	
Ambient	Md. Sel.	17.62	116.4	252.3	368.7	66
	Dollard	17.82	49.0	70.7	118.7	33
	Av.	17.71	82.2	161.5	243.7	50
10C	Md. Sel.	10.69	126.0	274.5	400.5	100
	Dollard	11.55	145.0	333.7	478.7	100
	Av.	11.45	135.5	304.1	439.6	100
21C	Md. Sel.	21.00	139.0	271.9	410.9	100
	Dollard	12.43	96.5	229.4	325.9	66
	Av.	16.71	117.8	250.6	368.4	83
32C	Md. Sel.	10.39	59.1	56.9	116.0	66
	Dollard	2.66	----	----	----	0
	Av.	6.52	29.5	28.4	58.0	33
Averages:	Md. Sel.	15.09	110.1	216.4	326.5	83
	Dollard	11.12	72.4	158.4	230.8	50
	Av.	13.11	91.2	186.4	277.6	66

Pasture Evaluation Using Beef Steers

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Purpose and Objectives

Livestock numbers in Maryland increased more than 10% between 1950 and 1960. This increase was due largely to increases in beef cattle, and the numbers continue to grow. During this same period, large decreases in cropland pasture acreages have taken place. If pastures are to continue to play a major role in the industry, greater production per unit of land must be realized. Small-plot studies have demonstrated the high forage-producing capacity of Midland Bermudagrass sod-seeded with cool-season annuals. The objectives of this study were to: (1) Determine the pasture production potential of Midland Bermudagrass plus sod-seeded annual species grown at two rates of nitrogen fertilization using beef feeder steers as test animals and (2) study the efficiency of Midland Bermudagrass pasture combinations as influenced by light supplemental grain feeding.

Procedures

A uniform, well-established stand of Midland was divided into one-half acre paddocks. A mixture of rye and wheat was sod-seeded into each paddock in early fall. The entire area was fertilized annually with 100 lbs of P_2O_5 and K_2O. The pH at the start of study was 6.5. Pasture treatment consisted of 200 and 400 lbs N per acre in four split applications and no grain vs. ground corn fed at the rate of 0.7 lb /day/100 lbs of live animal weight. The experimental design was a split plot with two complete replications. Four main plots within each replication comprised a "grazing cycle" with each of the four treatments assigned at random within each grazing cycle to form the sub-plots for a total of 32 test paddocks. Reserve pastures for each treatment were maintained so that extra animals could be added to or subtracted from each experimental pasture as forage production dictated.

Test animals were purchased at the fall feeder calf sale and uniformly fed during the winter. Just prior to being placed on the experimental pastures, they were divided into uniform groups according to weight and rate of winter gain. The groups were then assigned at random to the pasture treatments where they remained throughout the grazing season. Pastures were grazed rotationally with a rest period of 15 to 25 days depending on growing conditions.

Results

A brief summary of results obtained during the past three years is given in Table 1. Both nitrogen fertilization and grain feeding resulted in increased carrying capacities, animal gains per day, and pounds of beef produced per acre. Nitrogen fertilization did not increase the slaughter grade while grain feeding did. Except for slaughter grades, where there were only small differences, 1968 values were higher than for the three year averages. On the average (1966-1968) grain feeding increased beef production approximately 280 pounds per acre regardless of the nitrogen level; however, the high nitrogen fertilization increased production by only about half that amount. It appears from these data that, under grazing conditions, production leveled off around the 200 lbs nitrogen per acre. If one deducts the cost of sod-seeding, fertilizar and grain feeding, the greatest net return was at 200 pounds of N where grain was fed at 0.7 lbs per day per 100 pounds of live animal weight.

Summary

1. Pasture-carrying capacity was increased by nitrogen fertilizer and grain feeding.
2. Animal gains per day were increased by nitrogen fertilizer and grain feeding with the most marked effect from the latter.

3. Slaughter grade was increased by grain feeding while nitrogen fertilization had little effect.

4. Beef production per acre was increased by nitrogen fertilization and grain feeding with grain again giving the highest return.

5. Greatest economic return appeared to be with 200 pounds per acre of nitrogen with grain feeding.

Table 1. Beef production from Midland Bermudagrass sod-seeded with a rye - wheat mixture as affected by nitrogen fertilization and grain feeding.

Treatments	Year[1]	Carrying Capacity (1000 lbs) live wt. per acre	Daily Gain in lbs	Slaughter[2] Grade	lbs of Beef per acre
200 lbs N	1966	2.62	1.54	9.5	483
	1967	3.02	1.11	9.7	498
	1968	3.02	1.37	8.3	582
	Av.	2.89	1.34	9.2	532
200 lbs N + Grain	1966	3.36	1.92	11.3	751
	1967	3.55	1.76	12.7	780
	1968	3.53	2.11	12.3	925
	Av.	3.48	1.93	12.0	819
400 lbs N	1966	3.14	1.54	9.8	644
	1967	3.40	1.24	10.8	616
	1968	3.44	1.64	8.7	741
	Av.	3.33	1.47	9.8	667
400 lbs N + Grain	1966	3.78	1.85	11.7	885
	1967	4.10	1.70	12.3	911
	1968	4.00	2.06	11.8	1062
	Av.	3.96	1.87	11.9	953
Averages:					
1968 200 N		3.28	1.74	10.3	754
400 N		3.72	1.85	10.3	902
No Grain		3.23	1.50	8.5	662
Grain		3.76	2.08	12.0	994
	Av.	3.50	1.79	10.3	828
1966 to 1968 200 N		3.18	1.64	10.6	676
400 N		3.64	1.67	10.8	810
No Grain		3.11	1.40	9.5	600
Grain		3.72	1.90	12.0	886
	Av.	3.41	1.65	10.7	743

[1]Days of grazing 1966 - 187; 1967 - 220; 1968 - 228.

[2]Prime 15 - 17; Choice 12 - 14; Good 9 - 11; Utility - 8.

Table 1. Beef production from Midland Bermudagrass sod-seeded with a rye - wheat mixture as affected by nitrogen fertilization and grain feeding.

Treatments	Year[1]	Carrying Capacity (1000 lbs Live wt. per acre	Daily Gain in lbs	Slaughter[2] Grade	lbs of Beef per acre
200 lbs N	1966	2.62	1.54	P.5	403
	1967	3.02	1.11	9.7	498
	1968	3.02	1.37	8.3	582
	Av.	2.89	1.34	9.2	532
200 lbs N + Grain	1966	3.36	1.92	11.3	751
	1967	3.55	1.75	12.7	780
	1968	3.53	2.11	12.3	925
	Av.	3.48	1.93	12.0	819
400 lbs N	1966	3.16	1.54	9.8	664
	1967	3.40	1.24	10.8	616
	1968	3.44	1.64	8.7	741
	Av.	3.33	1.47	9.8	667
400 lbs N + Grain	1966	3.78	1.85	11.7	883
	1967	4.10	1.70	12.3	911
	1968	4.00	2.06	11.8	1062
	Av.	3.95	1.87	11.9	953
Averages:					
1968 200 N		3.28	1.74	10.3	754
400 N		3.72	1.85	10.3	902
No Grain		3.23	1.50	9.5	662
Grain		3.76	2.08	12.0	964
	Av.	3.50	1.79	10.3	823
1966 200 N		3.18	1.64	10.6	676
to 400 N		3.64	1.67	10.8	810
1968 No Grain		3.11	1.40	9.5	600
Grain		3.72	1.90	12.0	866
	Av.	3.41	1.65	10.7	753

[1]Days of grazing 1966 - 182; 1967 - 220; 1968 - 228.

[2]Prime 15 - 17; Choice 12 - 14; Good 9 - 11; Utility - 8.

Harvest Management of Crownvetch (*Coronella Varia* L.)

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Purpose and Objectives

Crownvetch has been used extensively for bank stabilization for years. It is now being considered by some as a potential forage crop and has shown considerable promise in this area. The purpose of this experiment was to study the effect of harvest frequency and height of stubble cut on dry matter production and stand longevity. A preliminary study was conducted in the greenhouse prior to moving to the field. The objectives of the study were: (1) To determine dry matter production as influenced by three harvest frequencies and three stubble heights, (2) to study the effect of these management variables on bud production, and (3) to study the effect of these variables on stand longevity.

Procedure

Greenhouse Experiment:

Emerald and Penngift crownvetch varieties were harvested at three stages of growth and cut at three stubble heights in a greenhouse study, started December 8, 1967. The design was a randomized complete block with three replications. The three growth stages were pasture (plants to be cut every four weeks), early hay (plants cut in bud stage), and late hay (majority of plants flowering). Each system was cut at 2.5-, 5.0-, and 7.5-cm stubble heights.

Dry matter production per pot was determined for each treatment. After each harvest, three equal-sized branches in each pot were tagged and the number of buds developing into new stems and leaves during the next two weeks were counted.

Field Experiment:

Only Penngift was used in the field study. The harvest frequencies were pasture, early hay, and late hay as with the greenhouse study, but stubble heights were 5.0, 7.5, and 10.0 cm. The design was a randomized complete block with five replications. Bud counts were taken on three plants per plot in two replications. Dry matter yields were taken with a rotary mower. Stand density and persistence were measured using a line transect.

Results

Emerald produced significantly more total dry matter than Penngift (Table 1). This was true on a per harvest basis as well as for total yield. Total production was similar for all three harvest frequencies with late hay being slightly higher. On an individual harvest basis, pasture was significantly lower. Stubble height had a small overall effect on dry matter yields with the low cut being slightly more productive. However, there was a significant interaction between harvest frequency and stubble height. With the pasture, the highest stubble gave the greatest yield while the reverse was true with early hay. There was no difference at late hay stage.

Bud production of the two varieties grown in the greenhouse is given in Table 2. There was little difference between the two varieties. The pasture treatment produced significantly more total buds than the two hay harvests. However, on a single harvest basis, these differences did not exist. Higher bud counts were generally associated with the higher stubble height, although the differences were not too large, especially at the two hay cuts.

Yield Experiment:

Only Penngift was used in the field study. The harvest frequencies were pasture, early hay, and late hay as with the greenhouse study, but stubble heights were 5.0, 7.5, and 10.0 cm. The design was a randomized complete block with five replications. Bud counts were taken on three plants per plot in two replications. Dry matter yields were taken with a rotary mower. Stand density and persistence were measured using a line transect.

Results

Emerald produced significantly more total dry matter than Penngift (Table 1). This was true on a per harvest basis as well as for total yield. Total production was similar for all three harvest frequencies with late hay being slightly higher. On an individual harvest basis, pasture was significantly lower. Stubble height had a small overall effect on dry matter yields with the low cut being slightly more productive. However, there was a significant interaction between harvest frequency and stubble height. With the pasture, the highest stubble gave the greatest yield while the reverse was true with early hay. There was no difference at late hay stage.

Bud production of the two varieties grown in the greenhouse is given in Table 2. There was little difference between the two varieties. The pasture treatment produced significantly more total buds than the two hay harvests. However, on a single harvest basis, these differences did not exist. Higher bud counts were generally associated with the higher stubble height, although the differences were not too large, especially at the two hay cuts.

Dry matter production in the field followed a similar pattern of that found in the greenhouse (Table 3) with the late hay being highest. Highest production was obtained at the low stubble height both on a total and a per harvest basis.

Summary

1. Emerald was more productive than Penngift.
2. Bud development was not closely related to dry matter production.
3. In the field the high stubble height was least productive while the reverse was true in the greenhouse.
4. The late hay cut was more productive than the early hay or pasture in the field as well as the greenhouse.

Table 1. The effect of harvest frequency and stubble heights on dry matter production of Penngift and Emerald Crownvetch. Greenhouse Study 1967-68.

Varieties	Stubble Heights (cm)	Management Systems			
		Pasture (g)	Early Hay (g)	Late Hay (g)	Av. (g)
Penngift	2.5	5.38	6.44	8.55	6.76
	5.0	4.35	4.81	4.68	4.61
	7.5	10.78	4.10	6.86	7.25
Av.		6.84	5.12	6.70	6.22
Av./harvest		.94	2.56	3.35	2.29
Emerald	2.5	5.98	10.08	11.03	9.03
	5.0	5.52	9.14	10.38	8.01
	7.5	9.45	5.70	5.59	6.91
Av.		6.98	8.31	9.00	8.10
Av./harvest		1.00	4.16	4.50	3.22
Averages:	2.5	5.68	8.26	9.79	7.91
	5.0	4.94	6.98	7.53	6.48
	7.5	10.12	4.90	6.23	7.10
Av.		6.91	6.71	7.85	7.16
Av./harvest		.99	3.36	3.93	2.76

Table 1. The effect of harvest frequency and stubble heights on dry matter production of Pennglit and Emerald Crownvetch. Greenhouse Study 1967-68.

Varieties	Stubble Heights (cm)	Management Systems: Pasture (g)	Early Hay (g)	Late Hay (g)	Av. (g)
Pennglit	2.5	5.38	6.44	8.55	6.76
	5.0	6.35	4.81	4.68	4.61
	7.5	10.78	4.10	6.86	7.25
Av.		6.84	5.12	6.70	6.22
Av./harvest		.94	2.56	3.35	2.25
Emerald	2.5	5.98	10.08	11.03	9.03
	5.0	5.32	5.14	10.38	8.01
	7.5	9.45	5.70	5.59	6.91
Av.		6.98	8.31	9.00	8.10
Av./harvest		1.00	4.16	4.50	3.22
Averages:	2.5	5.68	8.26	9.79	7.91
	5.0	4.84	6.59	7.53	6.48
	7.5	10.12	4.90	6.23	7.10
Av.		6.91	6.71	7.85	7.16
Av./harvest		.99	3.36	3.93	2.76

Table 2. The effect of harvest frequency and stubble height on bud development of Penngift and Emerald Crownvetch. Greenhouse Study 1967-68.

Varieties	Stubble Heights (cm)	Management Systems			Av.
		Pasture	Early Hay	Late Hay	
Penngift	2.5	141	44	60	82
	5.0	200	43	55	99
	7.5	247	55	66	123
Av.		196	47	60	101
Av./harvest		28.0	23.5	30.0	27.2
Emerald	2.5	190	48	61	100
	5.0	245	41	69	118
	7.5	198	37	61	99
Av.		211	42	64	106
Av./harvest		30.1	21.0	32.0	27.7
Averages:	2.5	165	46	60	90
	5.0	222	42	62	109
	7.5	222	46	63	110
Av.		204	44	62	
Av./harvest		29.1	22.3	31.0	

Table 2. The effect of harvest frequency and stubble height on bud development of Pennglit and Emerald Crownvetch. Greenhouse Study 1967-68.

Varieties	Stubble Heights (cm)	Management Systems: Pasture	Early Hay	Late Hay	Av.
Pennglit	2.5	161	44	60	82
	5.0	200	43	55	99
	7.5	247	55	66	123
Av.		196	47	60	101
Av./harvest		28.0	23.5	30.0	27.2
Emerald	2.5	150	48	61	100
	5.0	245	41	69	110
	7.5	198	37	61	99
Av.		211	42	64	106
Av./harvest		30.1	21.0	32.0	27.7
Averages:	2.5	165	46	60	90
	5.0	222	42	62	105
	7.5	222	46	63	110
Av.		204	44	62	
Av./harvest		29.1	22.3	31.0	

Table 3. The effect of harvest frequency and stubble heights on dry matter production of Penngift. Field Study 1968.

Stubble Heights (cm)	Management Systems (10^3kg/ha) Pasture	Early Hay	Late Hay	Av.	Av. per Harvest
5.0	2.66	2.43	3.15	2.75	1.23a*
7.5	2.10	1.97	2.76	2.28	1.02a
10.0	1.98	1.71	2.56	2.08	.93b
Av.	2.25 y	2.04 y	2.82 x		
Av./harvest	.75 s	1.02 r	1.41 q		

*Means followed by the same letter or letters from a common sequence (a-b) x-y, q-s) are not significantly different at the 5% level.

Table 3. The effect of harvest frequency and stubble heights on dry matter production of Pennglift. Yield Study 1968.

Stubble Heights (cm)	Management Systems (10^3 Kg/ha) Pasture	Early May	Late May	Av.	Av. per Harvest
5.0	2.66	2.63	3.15	2.75	1.23a*
7.5	2.10	1.57	2.75	2.28	1.02a
10.0	1.98	1.71	2.56	2.08	.93b
Av.	2.25 y	2.04 y	2.82 x		
Av./harvest	.75 a	1.02 z	1.41 q		

*Means followed by the same letter or letters from a common sequence (a-b) x-y, p-s) are not significantly different at the 5% level.

Midland Bermudagrass Forage Production, Feed Value, and Stand Persistence as Affected by Nitrogen Fertilization and Harvest Frequency

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Purpose and Objectives

The use of bermudagrass has increased markedly since the development of Coastal, and considerable information has been accumulated on the management and fertility requirements of this variety. Midland is grown just north of the Coastal Bermuda belt, and because of a more limited acreage much less is known about this variety. Midland has been extremely productive under Southern Maryland conditions as well as some areas in the Piedmont. The purpose of this study was to further study the forage producing capacity of this grass and, at the same time, obtain some information on its potential feed value. The objectives of this study, then, were to: (1) Determine dry matter production, seasonal forage distribution, and nitrogen recovery of Midland bermudagrass affected by harvest frequency and nitrogen fertilization. (2) Determine the forage quality of Midland hay as affected by nitrogen fertilization and harvest frequency.

Procedure

A uniform stand of Midland bermudagrass was fertilized with 0, 200, 400, and 600 lbs. N per acre in four equal split applications, and harvested 4, 5, and 7 times per growing season. The area was limed to a pH of 6.5 and fertilized annually with 150 lbs. P_2O_5 and 300 lbs. K_2O. The experimental design was a randomized complete block with four replications. In addition to this small-plot study, selected treatments were grown in large fields where the forage was harvested and fed to animals for some of the more critical quality evaluations.

Results

Average forage production over the three year period (1965-67) is given in Table 1. It can be seen that yields increased up to an application of 400 lbs. N per acre where they leveled off. Production also decreased as the number of harvests increased. These results are in agreement with earlier studies in Southern Maryland except yields were substantially higher in the earlier studies. Crude protein percentages are given in Table 1. In no case was the protein level extremely low. If a minimum of 200 lbs. N were applied, the percent never went below 15. The crude protein level increased with nitrogen fertilization and harvest frequency.

Not all of the feeding studies have been completed. The 1966 forage serves as a good example to illustrate the range in quality as measured by animal performance (Table 2). Both forage intake and digestibility were increased with frequent harvesting. Nitrogen fertilization also increased dry matter intake. Digestion coefficients were less affected by nitrogen.

Yields were taken in 1968 merely to measure the effect of residual nitrogen left from the previous three years. The area was inadvertently clipped in early June so no yields were obtained for the first harvest.

Two later harvests were made and these data are presented in Table 3. In contrast to earlier studies, where there was a large nitrogen carryover, no residual nitrogen effect was found. The forage samples will be analyzed for total nitrogen content. There was a color difference which did not reflect in differential yields.

The infestation of dandelion plants was rather heavy in some treatments so a count was made following the first harvest in 1968. These data are given in Table 3. Nitrogen fertilization greatly reduced weed infestation. There was also a tendency for fewer weeds in the more frequently harvested plots.

Summary

1. Yields were increased with nitrogen levels up to 400 lbs. per acre where they leveled off.
2. Yields decreased as the number of harvests were increased.
3. Crude protein values increased with nitrogen fertilization and harvest frequency.
4. Forage intake increased with harvest frequency and nitrogen fertilization.
5. Digestion coefficients increased with harvest frequency, but were little affected by nitrogen rates.
6. There was no measurable nitrogen carryover in terms of forage yield.
7. Weed infestation was markedly decreased with nitrogen fertilization, but only slightly decreased by increased harvest frequency.

Summary

Table 1. Forage production and crude protein percentages of Midland bermudagrass as affected by nitrogen fertilization and harvest frequency (1965-67).

Pounds N per acre	Hay 12% Moisture — Number of Harvests				Crude Protein — Number of Harvests			
	4	5	6	Av.	4	5	6	Av.
	T/A	T/A	T/A	T/A	%	%	%	%
0	2.49	1.93	1.49	1.97	11.1	13.1	13.3	12.5
200	5.49	4.82	3.50	4.60	15.6	16.2	16.6	16.1
400	6.90	5.59	5.03	5.84	17.9	19.9	20.4	19.4
600	6.49	6.28	5.16	5.98	19.7	21.1	22.6	21.1
Av.	5.34	4.66	3.80		16.1	17.6	18.2	

Table 2. Intake, digestion coefficients, and composition of Midland bermudagrass, 1966.

	200 lbs. N/A		600 lbs. N/A	
	4 cuts	5 cuts	4 cuts	5 cuts
Daily dry matter intake (% body wt.)	1.56	1.80	1.62	2.06
Digestion Coefficients:				
Energy (%)	56.6	64.4	52.9	63.9
Protein (%)	60.0	70.6	67.0	72.8
Crude Fiber (%)	68.8	77.6	63.9	76.0
Hay Composition (dry basis):				
Protein (%)	10.1	15.2	15.7	20.4
Crude Fiber (%)	33.1	29.3	34.0	30.8
Ash (%)	7.9	9.0	9.1	9.1

Table 3. Residual hay yields and dandelion populations on Midland plots as affected by nitrogen fertilization and harvest frequency (Treatments 1965-67, data 1968).

Pounds N per acre	Hay 12% Moisture				Dandelion Plants/plot			
	Number of Harvests				Number of Harvests			
	4	5	6	Av.	4	5	6	Av.
	T/A	T/A	T/A	T/A	No.	No.	No.	No.
0	.69	.98	.95	.87	33	62	59	51.0
200	.81	.74	.82	.78	13	12	29	18.0
400	.76	.69	1.01	.82	5	7	2	4.6
600	.81	.90	.73	.81	3	2	2	2.3
Av.	.77	.83	.87		13.5	20.7	23.0	

Table 3. Residual hay yields and dandelion populations on Midland plots as affected by nitrogen fertilization and harvest frequency (Treatments 1965-67, data 1968).

Pounds N per acre	Hay 12% Moisture				Dandelion Plants/plot			
	Number of Harvests				Number of Harvests			
	4 T/A	5 T/A	6 T/A	Av. T/A	4 No.	5 No.	6 No.	Av. No.
0	.89	.96	.95	.87	33	82	59	51.0
200	.81	.74	.82	.78	13	12	29	18.0
400	.76	.69	1.01	.82	5	7	2	4.6
600	.81	.90	.73	.81	3	2	2	2.3
Av.	.77	.83	.87		13.5	20.7	23.0	

The Use of Various Chemical Growth Regulators to Improve Ripening Rate and Maturity of Maryland Tobacco

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

There is a need for work on narrowing the range of maturities between the lower and upper leaves of the tobacco plant at harvest time. Maryland tobacco is stalk-cut at that critical time when the middle leaves are of optimum ripeness, the lower leaves are overmature, and the top leaves are immature. This wide range is a limiting factor to new procedures of harvesting and curing being developed for labor reduction.

The objective of this study is to compare the effect of various chemical growth regulators upon the rate of ripening and the maturity of cured leaves.

Procedure

This investigation was located on a Monmouth fine sandy loam at the Tobacco Experimental Farm. Catterton variety was planted at population of 7,260 plants per acre with 60-120-180 lbs. of fertilizer broadcast per acre. The design was a randomized complete block with three replicates. Plots were one row of 30 plants or a size of 3 by 60 ft.

The chemicals were applied just after topping by spraying over the top of the plant with a fine-mist spray on July 29, 1968.

Results

Dimethyl amino succinic acid, giberellic acid, T-405 and azauracil appeared worthy of further consideration since they were somewhat ahead of the control treatment in price per cwt. received for the tobacco and value per acre as shown in Table 1. The chemical T-417 also looked promising.

This resulted in the lower leaves changing to a yellowish-green color resembling ripening within a week of treatment date. The 2,4-D and 2,4,5-T treatments at the rates used caused tobacco to lose lower leaves fast and yield per acre was drastically reduced.

Summary

1. Several chemicals studied indicated promise for future work. Dimethyl amino succinic acid, giberellic acid, T-405, azauracil and T-417 should be tried with variation in rates, methods, and time of application.
2. The 2,4-D and 2,4,5-T compounds must be reduced in rate if included in future tests. The 50 mg. per plant rate is too great to give a fair comparison with the control.

This resulted in the lower leaves changing to a yellowish-green color resembling ripening within a week of treatment date. The 2,4-D and 2,4,5-T treatments at the rates used caused tobacco to lose lower leaves last and yield per acre was drastically reduced.

Summary

1. Several chemicals studied indicated promise for future work. Dimethyl amino succinic acid, gibberellic acid, T-405, asparagil and T-417 should be tried with variation in rates, methods, and time of application.
2. The 2,4-D and 2,4,5-T compounds must be reduced in rate if included in future tests. The 50 mg. per plant rate is too great to give a fair comparison with the control.

Table 1. Effect of various chemical growth regulators on yield, price and acre values of Maryland tobacco. 1968.

Treatment	Yield lbs/A	Price $/cwt.	Value $/acre
N Dimethyl Amino Succinic Acid	1534	66.97	1030
Giberellic Acid	1420	67.38	954
T-405	1432	66.17	945
Azauracil-Diethylamine Salt	1377	67.02	926
Control	1429	61.99	879
N 6 Benzyl Adenine	1341	59.36	796
T-417 (150 mg. per plant)	1279	61.72	791
T-417 (75 mg. per plant)	1249	59.61	744
2,4-D (50 mg. per plant)	932	63.83	596
2,4-D (100 mg. per plant)	768	62.24	479
2,4,5-T (50 mg. per plant)	800	57.44	467
2,4,5-T (100 mg. per plant)	665	51.00	338
L.S.D. (05)	284	6.90	208
(01)	386	9.40	283
C.V.	14.2%	6.6%	16.5%

Table 1. Effect of various chemical growth regulators on yield, price and acre values of Maryland tobacco, 1958.

Treatment		Yield lbs/A	Price $/cwt.	Value $/acre
N Dimethyl Amino Succinic Acid		1534	65.97	1030
Gibberellic Acid		1420	67.38	956
T-405		1432	66.17	945
Asuracil-Diethylamine Salt		1377	57.02	926
Control		1429	61.39	879
N 6 Benzyl Adenine		1341	59.36	796
T-417	(150 mg. per plant)	1275	61.72	791
T-417	(75 mg. per plant)	1249	59.61	744
2,4-D	(50 mg. per plant)	932	63.83	596
2,4-D	(100 mg. per plant)	768	62.24	479
2,4,5-T	(50 mg. per plant)	800	57.44	469
2,4,5-T	(100 mg. per plant)	655	51.00	339
	L.S.D. (05)	284	6.30	208
	(01)	386	5.40	283
C.V.		14.22	6.5%	16.5%

The Feasibility of Transplanting Tobacco Seedlings in Pressed Peat-Soil Cubes

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

The purpose of this work was to develop a different method of growing tobacco plants which would have potential for improved seedling uniformity, further mechanization of transplanting and labor reduction. The lack of uniformity -- because of irregular transplants -- has been one of the major problems in the total mechanization of tobacco harvesting. With agricultural crops, the more uniform the product, the easier it is to adapt to mechanization. This new system of producing seedlings in cubes offers a potential for mechanization of transplanting which does not exist under the conventional system of plant production.

The objectives of this study were:

1. To compare various ratios of soil, peat, vermiculite, and perlite in production of cubed transplants.
2. To investigate the effect of these various ratios, transplant water, and added nitrogen upon yield, price, acre value, and uniformity of tobacco.

Procedure

This experiment was located at the Tobacco Experimental Farm on a Donlonton fine sandy loam soil. Catterton variety was used at a plant population of 7,260 per acre. Fertilizer was broadcast at/rate of 60-120-180 lbs. per acre. Experimental design was a randomized complete block with four replicates. Plots were one row of 24 plants which was 3 by 48 ft. in size.

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2. To investigate the effect of these various ratios, transplant water, and added nitrogen upon yield, price, acre value, and uniformity of tobacco.

Procedure

This experiment was located at the Tobacco Experimental Farm on a Dunton fine sandy loam soil. Cattleron variety was used at a plant population of 7,250 per acre. Fertilizer was broadcast at\rate of 80-120-180 lbs. per acre. Experimental design was a randomized complete block with four replicates. Plots were one row of 24 plants which was 3 by 46 ft. in size.

Various percentages by volume of soil-peat-vermiculite and perlite were used in producing a cube 2 inches per side. The soil used was a Monmouth sandy loam. Four of the treatments include potassium nitrate in the mix at 3 pounds per 50 cubic ft. of mix. A control treatment consisted of transplants from a plant bed which were conventional except that a major effort was made to sort out an exceptionally uniform group of vigorous plants. This made a total of 11 treatments.

Observations were made on the ease and speed with which cubes could be produced from the various mixes. Growth rate of young tobacco seedlings was also observed.

The plants from the 11 treatments were then planted into field plots. The control and three other treatments were planted with a half pint of water added. The remaining seven treatments were planted dry.

Results

The field results are shown in Table 1 and indicated that there were no significant differences between any of the treatments in yield, price, or acre values. Thus, in this respect, any of the mixes tried performed satisfactorily. The estimates of relative uniformity with the control arbitrarily set at 100 were not conclusive but there appear to be some trends. The 35-35-20-10 combination appeared very uniform; whereas, the mixes containing potassium nitrate seemed to be less uniform.

Plants grown in cubes containing added potassium nitrate had an earlier and faster rate of growth before being transplanted into the field. These plants were more tender and were easily injured and damaged.

Differences occurred in the production of the cubes because of the composition of the mix used. Ratios exceeding 35% soil would stick to the press and reduce production rates. Where vermiculite or perlite made up 60% of the mix there was a problem of cubes crumbling when handled.

Summary

1. Field results of yield, price, and acre value indicated that all of the ratios tested were satisfactory.
2. Nitrogen included in the mix improved early growth in the plant bed but appeared to reduce uniformity.
3. Ratios containing high percentages of soil, vermiculite, or perlite were undesirable in producing cubes.
4. A ratio of 35-35-20-10 with no nitrogen was the most ideal combination in this test.

Table 1. Yield, price, acre value and uniformity of tobacco from transplants grown in different ratios of soil, peat, vermiculite and perlite. 1967.

Per cent by volume of soil-peat-vermiculite-perlite	Yield lbs/A	Price $/cwt.	Value $/A	Estimates of relative uniformity
(no transplant water)				
60-20-10-10	1579	68.25	1079	73
20-60-10-10	1484	66.86	994	87
20-20-60-0	1555	66.61	1039	85
20-20-0-60	1572	66.95	1052	84
20-50-20-10	1506	67.61	1017	105
35-35-20-10	1570	67.40	1063	116
35-35-20-10 + KNO_3	1521	67.04	1020	76
(plus transplant water)				
20-50-20-10 + KNO_3	1440	65.13	940	81
35-35-20-10 + KNO_3	1497	66.83	1005	68
30-30-20-20 + KNO_3	1490	65.66	982	55
Control	1640	68.08	1118	100
	N.S.	N.S.	N.S.	
C.V. =	9.4%	3.3%	11.4%	

Table 1. Yield, price, acre value and uniformity of tobacco from transplants grown in different ratios of soil, peat, vermiculite and perlite. 1957.

Per cent by volume of soil-peat-vermiculite-perlite	Yield lbs/A	Price $/cwt.	Value $/A	Estimates of relative uniformity
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60-20-10-10	1579	68.25	1079	73
20-60-10-10	1484	66.86	994	87
20-20-60-0	1553	66.61	1039	85
20-20-0-60	1572	66.95	1052	84
20-30-20-10	1506	67.61	1017	105
35-35-20-10	1570	67.40	1063	116
35-35-20-10 + KNO_3	1521	67.04	1020	76
(plus transplant water)				
20-30-20-10 + KNO_3	1440	65.13	940	81
35-35-20-10 + KNO_3	1497	66.43	1005	68
30-30-20-20 + KNO_3	1490	65.65	982	55
Control	1640	68.00	1118	100
	N.S.	N.S.	N.S.	
C.V. =	9.4%	3.3%	11.4%	

Effect of Harvesting Tobacco at Different Stages of Maturity and at Different Time Intervals After Topping

J. H. Hoyert
Department of Agronomy

Purpose and Objectives

The purpose of this investigation was to modify the harvest period and time of topping to study effects on uniformity of curing. The ultimate goal is to produce a plant that is better adapted to mechanization of harvest and which will require fewer man-hours in stripping and preparing for market. Harvest and market preparation make up approximately 150 man-hours per acre or 67% of total time required.

The objectives were:

1. To compare the effect of harvesting tobacco at different stages of maturity and at various intervals of time after topping upon yield, price, acre value, and filling capacity.
2. To investigate, through topping and harvesting modifications, procedures for producing tobacco of more uniform maturation that will be better adapted to mechanization.

Procedure

There were three field plot experiments on harvesting designed with four replicates in random complete blocks located on Monmouth sandy loam at the Tobacco Experimental Farm, Upper Marlboro. The Catterton variety was used at a 7,260 plant population per acre and 60-120-180 lbs. of fertilizer was broadcast per acre. Plot size was 2 rows of 20 plants each or a 6 by 40 ft. dimension. Tobacco was transplanted on June 5, 1967 in all three experiments.

Effect of Harvesting Tobacco at Different Stages of Maturity and at Different Time Intervals After Topping

J. M. Boyett
Department of Agronomy

Purpose and Objectives

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The objectives were:

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2. To investigate through topping and harvesting modifications, procedures for producing tobacco of more uniform maturation that will be better adapted to mechanization.

Procedure

There were three field pilot experiments on harvesting designed with four replicates in random complete blocks located on Monmouth sandy loam at the Tobacco Experimental Farm, Upper Marlboro. The Cattetron variety was used at a 7,260 plant population per acre and 60-120-180 lbs. of fertilizer was broadcast per acre. Plot size was 2 rows of 20 plants each or a 6 by 40 ft. dimension. Tobacco was transplanted on June 5, 1957 in all three experiments.

Experiment I: Tobacco was uniformly topped on July 28, 1967. There were six harvest dates: August 4th, 8th, 11th, 15th, 21st, and 25th. Treatment effects then were a combination of length of time in the field for ripening and the length of time that the tobacco was topped before harvest.

Experiment II: Harvest dates were August 8th, 11th, 15th, 18th, 25th, and 29th. The tobacco was in the field from 64 days through a maximum of 85 days thus giving a range of 21 days for ripening to take place.

Experiment III: Topping dates were July 28th, August 4th, 8th, 11th, 15th, and 19th and harvesting dates were August 8th, 11th, 15th, 18th, 25th, and 29th.

Results

Table 1 presents the results of 1967, the most recent year for which data are available for Experiment I. These results show that tobacco left in the field 81 days (topped 28 days) before harvest lost 285 lbs. per acre compared to plants harvested by 77 days. This was primarily because of "firing" and loss of bottom leaves. Price per cwt. increased with length of time in the field with exception of the last harvest date when the more valuable bottom leaves had fallen. This increase resulted from improvement in quality of top leaves at the later harvest dates. Filling capacity of dull and tip grades at the top of the plant improved with successive harvest dates and time topped which is an especially desirable characteristic for Maryland tobacco.

Results from Experiment II are presented in Table 2. A steady yield loss occurred over the entire range of 21 days. Leaf loss from firing and competition by reproductive parts of the plant reduced the growth of saleable leaves. Firing was greater as harvest dates proceeded. There was no loss at 1st harvest, but the loss ranged up to 7 to 8 leaves per plant at 6th

Experiment I: Tobacco was uniformly topped on July 28, 1897. There were six harvest dates: August 4th, 8th, 11th, 15th, 21st, and 25th. Treatment effects then were a combination of length of time in the field for ripening and the length of time that the tobacco was topped before harvest.

Experiment II: Harvest dates were August 8th, 11th, 15th, 18th, 22th, and 29th. The tobacco was in the field from 84 days through a maximum of 85 days thus giving a range of 21 days for ripening to take place.

Experiment III: Topping dates were July 28th, August 4th, 8th, 11th, 15th, and 18th and harvesting dates were August 8th, 11th, 15th, 18th, 22th, and 29th.

Results

Table I presents the results of 1897, the most recent year for which data are available for Experiment I. These results show that tobacco left in the field 81 days (topped 28 days) before harvest lost 285 lbs. per acre compared to plants harvested by 77 days. This was primarily because of "firing" and loss of bottom leaves. Price per cwt. increased with length of time in the field with exception of the last harvest date when the more valuable bottom leaves had fallen. This increase resulted from improvement in quality of top leaves at the later harvest dates. Filling capacity of dull and dip grades at the top of the plant improved with successive harvest dates and time topped which is an especially desirable characteristic for Maryland tobacco.

Results from Experiment II are presented in Table 2. A steady yield loss occurred over the entire range of 21 days. Leaf loss from firing and competition by reproductive parts of the plant reduced the growth of salvable leaves. Firing was greater as harvest dates proceeded. There was no loss at 1st harvest, but the loss ranged up to 7 to 8 leaves per plant at 6th

harvest date. Price per cwt. was not appreciably affected by harvest date although there was a trend for the earliest harvest and the last harvests to be somewhat lower in price. In the earliest treatment the top leaves were immature; whereas, the latest harvest dates resulted in tobacco that was overmature and with a smaller proportion of higher value "bright" grades.

Experiment III results are shown in Table 3. Yields were reduced markedly with later harvest dates. Days from planting to harvest beyond 74 showed over 200 lbs. per acre loss as well as a significant loss in quality as expressed by price per cwt. The value per acre was highest at 71 days although results of 64 through 74 days indicated no important differences. Tobacco cut after 81 days was 26% below the acre value of that harvested 10 days earlier. Harvests after 85 days were 34% lower in acre value than the 71 day harvest. The earliest harvest date of 64 days resulted in an undesirable lower filling capacity indicating that this tobacco would fill fewer cigarettes per pound. No trends were noted in total alkaloids because of stage of maturity. The per cent total nitrogen showed a tendency to decrease with increasing maturity.

Summary

Experiment I:

1. Gross acre value was not affected significantly by time of harvest and length of time topped except at the last harvest date when firing reduced yield and value.
2. Uniformity of quality among leaves on a stalk was improved at the 71 and 77 day harvest date. There was less difference between leaf qualities from the bottom of the stalk through the topmost leaves which resulted in a plant better adapted to mechanization.

Experiment II:

1. Harvesting by this system of topping at time of cutting should take place at early stage of maturity -- less than 71 days under conditions of this test.
2. The drastic reduction in yield and probably competition from suckers and flower heads suggest that there will be no place for this harvest system in future mechanization programs.

Experiment III.

1. Time of harvesting under these conditions would be optimum at 71 to 74 days after planting. In terms of acre value, harvesting at 64 days would be practical if labor availability was an important criterium.
2. Quality at the 64 day harvest date was affected by immaturity in the top of the plant. Conversely quality was reduced in the lower leaves of the plant because of overmaturity in the 81 and 85 day harvests.
3. Uniformity among leaves on a stalk was best at the intermediate harvest dates so that mechanization of harvest would probably be better at this time. However, overmature plants which have lost lower leaves may be more adaptable to guiding machinery and belt conveying of plants even though yield is sacrificed.

Table 1. Effect of harvest dates and length of time topped upon tobacco yield, price, acre value, and filling capacity, 1967.

No. days topping to harvest	No. days planting to harvest	Yield lbs. per acre	Price $/cwt.	Value $/acre	Filling capacity cc/gm
7	60	1576	74.32	1169	5.60
11	64	1573	73.86	1162	5.70
14	67	1651	74.88	1236	6.20
18	71	1535	77.75	1193	6.56
24	77	1562	79.14	1236	7.22
28	81	1277	76.31	975	7.52
	L.S.D. (05)	196	1.79	149	.81
	(01)	---	2.48	---	1.12
	C.V.	8.6%	1.6%	8.5%	8.3%

Table 2. Effect of harvesting at different stages of maturity of tobacco topped at time of harvest on yield, price, acre value, and filling capacity, 1967.

Days planting to harvest	Yield lbs/acre	Price $/cwt.	Value $/acre	Filling Capacity in cc/gm. seconds	bright	dull
64	1462	69.80	1021	7.26	7.00	6.68
67	1408	72.46	1019	7.10	6.68	6.56
71	1231	70.26	866	6.62	6.56	6.26
74	1149	73.87	849	6.36	6.48	6.40
81	1081	68.03	737	7.08	6.80	7.38
85	1089	69.55	760	7.22	7.16	7.20
L.S.D. (05)	169	---	142	.58	.39	.69
(01)	235	---	197	---	---	---
C.V.	9.1%	4.3%	12.2%	5.6%	3.8%	6.8%

Table 1. Effect of harvest dates and length of time topped upon tobacco yield, price, acre value, and filling capacity, 1957.

No. days topping to harvest	No. days planting to harvest	Yield lbs. per acre	Price $/cwt.	Value $/acre	Filling capacity cc/gm
7	80	1576	74.32	1169	5.60
11	64	1573	73.86	1162	5.70
14	87	1651	74.28	1236	6.30
18	71	1535	77.75	1193	6.36
24	77	1562	75.14	1236	7.22
28	81	1272	76.31	975	7.52
	L.S.D. (05)	196	1.79	146	.81
	(01)	---	2.48	---	1.12
	C.V.	8.6%	1.8%	8.5%	8.3%

Table 2. Effect of harvesting at different stages of maturity of tobacco topped at time of harvest on yield, price, acre value, and filling capacity, 1957.

Days planting to harvest	Yield lbs/acre	Price $/cwt.	Value $/acre	Filling Capacity in cc/gm. second	weight	dull
64	1462	69.80	1021	7.26	7.00	6.68
67	1408	72.46	1015	7.10	6.58	6.56
71	1231	76.26	956	6.62	6.56	6.26
74	1149	73.87	846	6.36	6.48	6.40
81	1081	68.03	737	7.08	6.80	7.38
85	1089	69.55	760	7.22	7.16	7.20
L.S.D. (05)	169	---	142	.58	.39	.59
(01)	235	---	197	---	---	---
C.V.	9.1%	4.3%	12.2%	5.6%	3.8%	6.8%

Table 3. Effect of harvesting at different stages of maturity with tobacco topped 10 days upon yield, price, acre value, filling capacity, total nitrogen, and total alkaloids, 1967.

Days planting to harvest	Yield lbs/acre	Price $/cwt.	Value $/acre	F.C. gg/cm.	Total N %	Total alkaloids %
64	1507	67.90	1025	6.20	3.79	2.38
67	1511	65.18	980	7.08	2.97	1.90
71	1543	67.67	1044	7.40	2.83	2.06
74	1403	71.81	1006	7.12	2.88	1.88
81	1193	64.29	768	7.18	2.70	2.06
85	1125	60.93	685	7.52	2.64	2.00
L.S.D. (05)	232	5.68	163	.61		
(01)	322	----	226	.85		
C.V.	11.2%	5.7%	11.8%	5.8%		

Table 3. Effect of harvesting at different stages of maturity with tobacco topped 10 days upon yield, price, acre value, filling capacity, total nitrogen, and total alkaloids, 1957.

Days planting to harvest	Yield lbs/acre	Price $/cwt.	Value $/acre	F.C. gr/cm.	Total N %	Total alkaloids %
64	1507	67.90	1025	6.20	3.79	2.38
67	1511	65.18	980	7.08	2.97	1.90
71	1543	67.67	1044	7.40	2.83	2.06
74	1403	71.81	1006	7.12	2.88	1.88
81	1193	64.29	768	7.18	2.70	2.03
85	1125	60.93	685	7.22	2.64	2.00
L.S.D. (05)	232	5.68	163	.61		
(01)	322	----	226	.85		
C.V.	11.2%	5.7%	11.8%	5.0%		

Tobacco Topping Studies

C. G. McKee
Department of Agronomy

Purpose and Objectives

1. To investigate the potential of chemicals for topping Maryland tobacco. Contact-type chemicals have long been used for sucker control in the tobacco area. If a contact acting chemical can be satisfactorily used to kill the flower bud, it would save one operation that is now carried out by hand.
2. To study the effects of various hand topping methods on the yield, quality, chemical content and physical characteristics of Maryland tobacco. Topping practices can influence time of ripening and the uniformity of the cured plants. Low, early topping could be used to gain an extra week of harvesting thus spreading out labor. More uniformity of the cured plants will speed stripping and grading and would be better adapted to mechanization.

Procedure

1. Chemical Topping

The chemical-topping studies were conducted in cooperation with the USDA. Chemicals were screened in 1967 and one, 1-decanol, was found to give satisfactory results. The chemical 1-decanol is a contact killer and has to be applied before the flower buds start to branch. The timing of application proved to be very critical in 1967 because not all plants would be in the proper stage for application of the chemical at the same time. Because of this, in 1968 a non-blooming Maryland Mammouth variety of tobacco was used.

The experiment was set up for 1968 with three topping treatments: chemical topping, hand topping, and hand topping with chemical sucker control. Treatments were applied at 5 different stages of growth: 12, 18, 24, 30, and 36 leaf stages.

2. Methods of Hand Topping

Earlier work indicated some advantages to low topping in that the tobacco could be harvested earlier and grading was easier because there were fewer sorts to be made. A study was started in 1967 testing 3 methods of low topping height compared with 3 methods of medium or normal topping height. Treatments tested in 1967 and 1968 were:

Treat. No.	Topping height	Topping time
1	Low - 13 leaves	early - before flower
2	Low - 13 leaves	allow to flower & break down
3	Low - 13 leaves	bud top and re-top
4	Medium - 18 leaves	before flower
5	Medium - 18 leaves	at flower
6	Medium - 18 leaves	bud top and re-top

Results

1. Chemical Topping

The 1968 results are not complete, but the results from the 1967 test are summarized in Table 1. Treatment 1, Chemical topping, also gave satisfactory sucker control until harvest. This treatment was superior to Treatment 4, the normal topping practice, in both yield and dollar return. Quality as indicated by $/cwt. was slightly lower for the chemical treatment when compared to the normal topping practice, but this difference was not significant.

The experiment was set up for 1958 with three topping treatments: chemical topping, hand topping, and hand topping with chemical sucker control. Treatments were applied at 5 different stages of growth: 12, 18, 24, 30, and 36 leaf stages.

2. Methods of Hand Topping

Earlier work indicated some advantages to low topping in that the tobacco could be harvested earlier and grading was easier because there were fewer sorts to be made. A study was started in 1957 testing 3 methods of low topping height compared with 3 methods of medium or normal topping height. Treatments tested in 1957 and 1958 were:

Treat. No.	Topping height	Topping time
1	Low - 13 leaves	early - before flower
2	Low - 13 leaves	allow to flower & break down
3	Low - 13 leaves	bud top and re-top
4	Medium - 18 leaves	before flower
5	Medium - 18 leaves	at flower
6	Medium - 18 leaves	bud top and re-top

Results

1. Chemical Topping

The 1958 results are not complete, but the results from the 1957 test are summarized in Table 1. Treatment 1, Chemical topping, also gave satisfactory sucker control until harvest. This treatment was superior to Treatment 4, the normal topping practice, in both yield and dollar return. Quality as indicated by $/cwt. was slightly lower for the chemical treatment when compared to the normal topping practice, but this difference was not significant.

2. Methods of Hand Topping

The results for the 1967 topping test are given in Table 2. Treatment 5 would be considered the normal topping practice used in the area. There were significant differences in yield and $/cwt., but not for $/acre. Treatments higher in yield were lower in price per pound and vice versa, thus, there was no significance in $/acre.

Summary

The results from the 1967 chemical topping work indicate that chemicals can be satisfactorily used to top Maryland tobacco. These results have been submitted for publication as a Research Note in Tobacco Science co-authored with Dr. G. L. Steffens, USDA.

The results from the 1967 hand topping experiment indicate that tobacco can be topped lower than the normal height without loss in gross per acre dollar return. This is only one seasons results and should be viewed as such. This experiment will be continued through 1969.

Table 1. Results of chemical topping experiments.

Treat. No.	Treatment: Topping	Treatment: Sucker Control	lbs/acre	$/cwt.	$/acre
1	1-decanol (Button)	None	2105 a	55.7 a	1169 a
2	Hand (Button)	Hand	1741 bc	56.0 a	974 b
3	Hand (Button)	1-Octanol and 1-decanol mix	1929 ab	56.1 a	1080 ab
4	Hand (Full Flower)	Hand	1704 c	58.8 a	1002 b
5	Hand (Full Flower)	1-Octanol and 1-decanol mix	1824 bc	55.5 a	1008 b

Table 2. Results of experiments on various methods of hand topping.

Treat. No.	Yield lbs/acre	$/cwt.	$/acre	% Total nitrogen	% Total alkaloids	Filling capacity cc./gm.
1	1382	67	930	2.25	.94	7.0
2	1265	71	900	2.04	1.09	7.7
3	1205	72	872	2.29	.91	7.6
4	1430	67	961	2.40	1.12	7.2
5	1321	65	865	2.32	1.17	7.3
6	1343	69	927	2.32	.86	7.7
LSD .05	141	4	NS	NS	NS	NS

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4	Hand (Full Flower)	Hand	1704 c	58.9 a	1002 b
5	Hand (Full Flower)	1-Octanol and 1-decanol mix	1824 bc	55.5 a	1008 b

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Treat. No.	Yield lbs/acre	$/cwt.	$/acre	% Total nitrogen	% Total alkaloids	Filling capacity cc./gm.
1	1302	67	930	2.25	.94	7.0
2	1265	71	900	2.04	1.05	7.7
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5	1321	65	865	2.32	1.17	7.3
6	1343	65	927	2.32	.86	7.7
LSD .05	141	4	NS	NS	NS	NS

Some Physio-Chemical Relationships of Maryland Tobacco with Respect to Cultural and Fertilization Practices, and Genetic Origin

Orman E. Street
Department of Agronomy

Purpose and Objectives

The acceptability of Maryland tobacco to the cigarette industry depends to a large degree on the unique physio-chemical properties of the leaf. These properties are due to climatic and soil factors, to genetic material, and finally to fertilization, curing and fermentation practices.

A shift in preference toward tobacco of lower alkaloid content has resulted from the current controversy on smoking and health. Likewise, the tobacco trade has found that more than a trace of nornicotine results in a bitter tasting smoke. A lower content of total nitrogen is also desirable. All three factors can be controlled by selection within genetic material, but persistent testing and screening must be practiced.

The so-called "free burning" property of Maryland tobacco is closely related to the porous structure of the leaf which allows an adequate oxygen supply for combustion.

The bulk density of the leaf, as measured by compression of a shredded sample under standard conditions, is related to filling capacity in the cigarette. The determination of bulk density, plus the measurement of duration of burn, helps to evaluate the acceptability of varieties and breeding lines of Maryland tobacco.

Cigarette smoking tests, run under standardized conditions, similar to the methods adopted by state, federal, and industry laboratories, aid in establishing the smoking qualities of Maryland tobacco relative to "American Blend" cigarettes.

Procedure

Total nitrogen was determined by the Ranker semi-micro Kjeldahl method and the total alkaloids by steam distillation as outlined by Griffith. The paper chromatography technique of Jeffrey and Tso was used for the detection of nicotine and nornicotine. The smoking apparatus was modeled after Ogg's description, as well as later modifications.

Swiss cigarettes are composed mostly of Maryland tobacco (about 75%) with the balance being Italian and indigenous tobaccos. American blend cigarettes contain the following: flue-cured 55%, burley 45%, oriental 8-9%, Maryland 1-2%. Standard smoking tests were run to determine the amounts of nicotine and total particulate matter in the smoke of both types of cigarettes.

Exploratory tests were conducted to determine the effects of high intensity gamma radiation from a Cobalt-60 source on the curing of Maryland tobacco. The facilities used were located at the Goddard Space Flight Agency of NASA at Greenbelt. Paul Winn of the Agricultural Engineering Department cooperated in these tests, while NASA was represented by Mr. Fred Gordon. Whole plants of Catterton tobacco were exposed to varying dosages ranging from 9000 rads to 180,000. Samples were oven-dried, and analyzed for total nitrogen and total alkaloids.

Results

Chemical determinations for total nitrogen and total alkaloids were made on 1150 samples of varietal materials of the 1968 crop. Screening for nicotine-nornicotine ratios disclosed only 2 breeding lines in 120 with unsatisfactory ratios.

A total of 172 representative farmer samples were obtained from the 1968 crop. No differences due to geographical location were noted. The overall average content of total nitrogen was 2.17 per cent, of total alkaloids, 2.60 per cent, both highly desirable levels. By comparison, 1967 farmer crops averaged 2.29 per cent total nitrogen and 2.30 per cent total alkaloids.

Seven Maryland varieties and nine advanced breeding lines were grown in three locations in a replicated test. Alkaloids and total nitrogen contents were higher at Upper Marlboro, Prince George's County, than at Davidsonville, Anne Arundel County, or Dentsville, Charles County. Again, all were acceptable. Duration of burn was markedly better at Davidsonville than the other two places. Filling capacity was not greatly different at the several locations, but differed significantly among varieties in each test, as did the duration of burn.

Results of the smoking tests are to be found in Table 1 at the end of the report.

The non-filter, 70-mm cigarettes were very similar in all respects. The 90-mm Parisiennes were lower in alkaloids but higher in "tars" than popular American blend cigarettes.

Chemical composition as measured by nitrogen and alkaloid contents of the leaf was not affected in any way by massive dosages of gamma radiation from a Cobalt-60 source. No bad effects on curing were noted.

Summary

Chemical and physical analyses of varietal and breeding lines furnished a measure of acceptability. Screening for the presence of nornicotine disclosed only 2 lines with detectable amounts. Filling capacity and burn varied significantly among varieties, and burn varied with location.

Cigarettes of Swiss manufacture, mainly composed of Maryland tobacco, were not lower in total particulate matter than "American Blend" but when a filter was added, they were definitely lower in nicotine.

The use of gamma radiation in massive amounts did not cause any unusual physical changes in curing, nor was the chemical composition different.

Table 1. Contents of total particulate matter (TPM) and nicotine in the smoke of cigarettes.

	TPM mg./cig.	Nicotine mg./cig.
Parisiennes, regular	17	1.7
Lucky Strike, regular	18	1.4
Camels, regular	13	1.0
Parisiennes, super (king size filter)	18	0.6
Marlboro 100's	12	1.7
L & M 100's	10	1.4
Winston 100's	10	1.1

Factors Related to Irrigation of Tobacco

O. E. Street
Department of Agronomy

Purpose and Objectives

The land which remains in agricultural usage in Southern Maryland must be used with the utmost efficiency. The pressure of urbanization exists in all parts of the area. It may be a differential type of pressure, as the well-drained, open-textured soils are preferred for both urban uses and farming.

Crops with a low return cannot be justified on expensive farm land. As the crop with the highest acre return, tobacco can also justify the investment in irrigation equipment.

The growth of tobacco should be rapid and uninterrupted. During periods of inadequate soil moisture, the plant develops thick leaves, coated with waxy material which enable the plant to restrict evapotranspiration. When moisture is again adequate, growth is resumed, but the physical and chemical changes cannot be reversed, and the final product is less desirable to the buyer, manufacturer, and ultimate consumer.

The crop with rapid growth can be harvested earlier and cured under more favorable conditions of temperature and humidity than a later maturing crop.

The objectives of this experiment are:

To determine the optimum conditions for response to irrigation in terms of yield, quality, chemical composition, and physical properties of Maryland tobacco.

To determine the effect of delayed application of nitrogen on the growth characteristics of the plant.

To determine the differential response of standard and newly released varieties to optimum levels of plant nutrients and moisture.

Procedure

The experiment was designed on a split-split-plot basis. Main plots were irrigation versus no irrigation, first split was time and amount of application of nitrogen sources, second split was variety. With 4 replicates, 2 main treatments, 4 first split and 5 second split, the total number of plots was 160.

The experiment was conducted at the University of Maryland Tobacco Experimental Farm near Upper Marlboro. The soil type was Monmouth loamy fine sand. The area had been in tobacco from 1955 through 1963, followed by tall fescue sod for four years.

The main plots were 49' 4" by 52' 8". These were divided into four sub-plots, 24' 8" by 26' 4", an area of .0149 acre each. Plot rows were 42" wide for ease of cultivation, with plants 21 inches in the row, an acre population of 7112 plants. The row length per plot accommodated 14 plants, with 12 plants saved for a plot sample.

The second split was a single row in each sub-plot, with each of five varieties appearing in each fertilizer sub-plot of the first split, 32 sub-plots in all. The experimental sample of 12 plants represented 1/593 acre.

Fertilization before planting was a uniform broadcast application equivalent to 1000 pounds per acre of a 3-18-27 experimental mixture. It was composed of nitrate of potash, sulfate of potash, and 20% superphosphate. The variables were:

1. Addition of ammonium nitrate equivalent to 60 pounds per acre of N to preplant treatment of 30-180-270.

To determine the differential response of standard and
newly released varieties to optimum levels of plant nutrients
and moisture.

Procedure

The experiment was designed on a split-split-plot basis. Main plots were irrigation versus no irrigation, first split was time and amount of application of nitrogen sources, second split was variety. With 4 replications, 2 main treatments, 4 first split and 5 second split, the total number of plots was 160.

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The main plots were 49' 4" by 52' 8". These were divided into four sub-plots, 24' 8" by 26' 4", an area of .0145 acre each. Plot rows were 42" wide for ease of cultivation, with plants 21 inches in the row, an acre population of 7112 plants. The row length per plot accommodated 14 plants, with 12 plants saved for a plot sample.

The second split was a single row in each sub-plot, with each of five varieties appearing in each fertilizer sub-plot of the first split, 32 sub-plots in all. The experimental sample of 12 plants represented 1/593 acre.

Fertilization before planting was a uniform broadcast application equivalent to 1000 pounds per acre of a 3-18-27 experimental mixture. It was composed of nitrate of potash, sulfate of potash, and 20% superphosphate.

The variables were:

1. Addition of ammonium nitrate equivalent to 80 pounds per acre of N to preplant treatment of 30-120-270.

2. Basic preplant plus ammonium nitrate equivalent to 30 pounds per acre of N, applied at 10 days and 20 days after planting and worked into soil.

3. Basic preplant plus ammonium nitrate equivalent to 60 pounds per acre of N, applied 10 days after planting and worked into soil.

4. Basic preplant plus ammonium nitrate equivalent to 60 pounds per acre of N, applied 20 days after planting and worked into soil.

The second split was five varieties as follows:

Catterton

Md. 64

Md. 59

Md. 609

Exp. J-66-3F-1 (released as Md. 10)

Soil moisture levels were measured by tensiometers placed in the row between plants, with the upper end of the cups at 4 inches below the level of the soil, the lower end at 7 inches. Bouyoucous gypsum blocks were inserted laterally in the soil at 4, 8, 12, and 20 inches to supplement the tensiometer readings, both of which were taken three times weekly. Irrigation was used when moisture deficits in the surface 7 inches approached 1 atmosphere.

The overhead irrigation lines of the Skinner system paralleled the plot rows and were capable of applying 1/3 inch per hour of water uniformly to the plots.

Results

1968 was not an unusually dry year. Rainfall for June, July, and August was 4.33, 1.78, and 5.04 inches, respectively, a total of 11.15 inches. The driest period was the 28 days from July 5 to August 3, when only .35 inch was recorded. Supplemental irrigation totaled 3.5 inches from July 24 to August 2. During the period August 3-11, inclusive, 2.70 inches of rain fell; the soil moisture deficits in the non-irrigated plots were largely removed and the tobacco in all plots made excellent growth until harvested on the 29th of August. The results are summarized in Table 1.

The five varieties chosen represent the four most popular current varieties, plus Maryland 10 now being released for 1969 farmer use. Maryland 10 is described as a mosaic-resistant Catterton-type tobacco, and in this test was nearly equal or better than Catterton under both moisture levels. Md. 59 and Md. 609, the two black-shank resistant varieties continued to display their outstanding quality as evidenced by high price per pound, plus high yield and acre value. Maryland 64 was a high yielder because of its Wilson parentage, but was characterized by green colors in the cured leaf, and suffered a sharp loss in price per pound. It must be recognized that 90 pounds per acre of nitrogen is excessive for Md. 64, and is not a recommended rate.

Differences due to method of nitrogen application were very meager, the lone exception being the lowered yield with the 30-0-60 split without irrigation. However, there was not a decrease in price per pound with the 20-day delay in application of nitrogen, either with or without added water. It should be recognized that results of a single years test of this type of treatment are not conclusive, largely because of rainfall distribution and related climatic effects.

The overall differences due to irrigation were not spectacular, but did show gains of 168 pounds per acre, 1.11 cents per pound of cured leaf, and $127 per acre in total value.

Summary

Modest responses to irrigation of tobacco in terms of increased yield and acre value were obtained in 1968. Adequate rains in early August nearly overcame the soil moisture deficit following a dry July.

Delayed application of nitrogen carriers had no adverse effects when irrigation was used. There was a more marked decrease in yield without irrigation when the larger part of the nitrogen was sidedressed 20 days after planting.

Varietal responses to irrigation in pounds per acre, ranged from 73 pounds gain for Catterton to 247 pounds gain for Md. 609, with a mean gain of 168 pounds. The gains in acre value ranged from $43 per acre for Catterton to $181 for Md. 609 with a mean gain of $127. Increased price per pound due to irrigation was found in only three of the five varieties, but there was an average gain of 1.11 cents.

Table 1. Summary of effects in tobacco irrigation studies, 1968.

Treatment Variable Variety	Irrigated Yield lbs/A	Irrigated Price ¢/lb.	Irrigated Value $/A	Non-irrigated Yield lbs/A	Non-irrigated Price ¢/lb.	Non-irrigated Value $/A
Catterton	1829	65.83	1204.07	1756	66.13	1161.33
Md. 64	2225	52.76	1173.89	2032	49.83	1012.48
Md. 59	1845	67.27	1241.19	1673	67.45	1128.48
Md. 609	1934	72.99	1404.36	1687	72.52	1223.48
Md. 10	1938	63.56	1231.87	1783	61.29	1092.80
Mean	1954	64.03	1251.08	1786	62.92	1123.71
Nitrogen Split (1)						
90-0-0	1944	63.93	1242.79	1809	64.64	1168.37
30-30-30	1960	62.91	1233.13	1799	59.26	1066.07
30-60-0	1957	63.27	1238.18	1809	61.83	1118.45
30-0-60	1947	66.26	1290.00	1731	65.91	1140.96
Mean	1954	64.03	1251.03	1786	62.92	1123.71

(1) First number is pounds per acre of nitrogen in a complete fertilizer applied broadcast before planting. Second number refers to nitrogen side dressed 10 days after planting, third number refers to nitrogen side dressed 20 days after planting. Complete fertilizer formula, home-mixed, supplied 90-90-270 lbs/A, respectively, of N, P_2O_5, and K_2O. A basic 3-9-27 mixture used before planting contained nitrate of potash, sulfate of potash and 20% superphosphate. Additional 60 lbs/A of nitrogen was obtained from ammonium nitrate in each treatment as required.

Chickweed Control in Dormant Alfalfa with Paraquat, Diquat, and Experimental Herbicides

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

The control of chickweed (Stellaria Media (L.) Cyrillo) has become a major problem in alfalfa (Medicago sativa L.). A dense population of chickweed can not only reduce alfalfa yields but has also been reported to adversely affect the control of weevil by flaming. The objective of this study was to evaluate paraquat and diquat sprayed on dormant alfalfa as a desiccant prior to flaming, and evaluate several experimental herbicides for chickweed control in dormant alfalfa.

Procedure

This paper reports two experiments conducted to find new and better methods of chickweed control in alfalfa. Established dormant Williamsburg alfalfa and orchardgrass (Dactylis glomerata L) heavily infested with chickweed were treated at the Agronomy Dairy Forage Research Farm, Clarksville, Maryland and at Ringgold, Maryland. Chickweed control was recorded as an estimate of the percentage of ground covered by chickweed. The spray volume was 30 gpa. The experimental design was a randomized complete block with three replications.

Experiment 1 at the Agronomy Dairy Forage Research Farm, was treated on March 9, 1968. Treatments are given in Table 1. Chickweed control values were taken on April 22 and May 9.

Experiment 2 at Ringgold, Maryland consisted of 23 treatments applied in mid-December, 1967 and again on March 25, 1968.

Results

EXPERIMENT NUMBER 1. The most promising experimental herbicides were RH 315 at 2 lb/A and Benezolin at ½ lb/A. Only the RH 315 and Benezolin treatments were harvested; in every case, except one, yields were higher than the weed free control. The exception was RH 315 at 4 lb/A which almost completely eliminated the orchardgrass from the plots. On the other hand, alfalfa yields were significantly increased.

EXPERIMENT NUMBER 2. Fall application of diuron, simazine, CIPC, terbacil, and dicamba resulted in 90% or better chickweed control; however, spring applications were not as effective (Table 2). A fall and spring application of diuron at 1.5 lb/A and fall applied simazine reduced alfalfa-grass yields. Diuron formulated on fertilizer was as effective as spray formulation; although 33% vigor reduction was recorded from diuron formulated on fertilizer, yields were not affected.

Dichlobenil and terbacil proved too injurious at 1 lb/A and 0.4 lb/A, respectively which reduced yields. Dicamba almost completely eliminated the alfalfa.

Summary

Of the experimental herbicides evaluated, RH 315 and Benezolin effectively controlled chickweed. RH 315 at 4 lb/A almost completely eliminated the established orchardgrass, and alfafla yields were significantly increased when compared to the weed-free check.

Fall applications of simazine, diuron and CIPC were quite effective in controlling chickweed. Terbacil and dichlobenil reduced yields, while dicamba almost completely eliminated alfalfa. Diuron formulated on fertilizer was as effective as a sprayed treatment.

Table 1. An evaluation of herbicides for chickweed control in alfalfa, 1968.

Treatment	lb/A	% Chickweed Control		Tons/A of Dry Matter Harvest 1	
		Apr. 22	May 9	Alfalfa	Grass
Control	-	3.3	0.0	0.42	0.21
RH 315	1	75.8	50.0	0.58	0.21
	2	84.2	100.0	0.52	0.54
	4	95.0	100.0	0.76	0.01
Benezolin	1/8	58.3	33.3	-	-
	1/4	65.8	73.0	0.57	0.67
	1/2	98.3	100.0	0.71	0.31
AC 72, 031	1/8	13.3	0.0	-	-
	1/4	61.7	33.3	-	-
	1/2	16.7	0.0	-	-
DNBP	1	10.0	0.0	-	-
CIPC	2	36.7	66.7	-	-
			LSD 0.05 =	0.30	0.40

Table 1. An evaluation of herbicides for chickweed control in alfalfa, 1966.

Treatment	lb/A	% Chickweed Control		Tons/A of Dry Matter	
		Apr. 22	May 9	Harvest 1 Alfalfa	Grass
Control	-	3.3	0.0	0.42	0.21
EH 315	1	75.0	50.0	0.58	0.21
	2	94.2	100.0	0.52	0.34
	4	95.0	100.0	0.76	0.01
Benzolin	1/8	58.3	33.3	-	-
	1/4	55.0	73.0	0.37	0.67
	1/2	98.3	100.0	0.71	0.31
AC 72, 031	1/8	13.3	0.0	-	-
	1/4	61.7	33.3	-	-
	1/2	15.7	0.0	-	-
DNBP	1	10.0	0.0	-	-
CIPC	2	36.7	66.7	-	-
			LSD 0.05 =	0.30	0.40

TABLE 2 - Washington Co. Chickweed Control in Established Dormant Alfalfa, 1968

Herbicide	Time of Year	lb/A	Ratings: % Chickweed Kill 1/ April 16	% Chickweed Kill 1/ May 17	%Alfalfa Vigor 1/ April 16	%Alfalfa Vigor 1/ May 17	Grass Vigor 1/ April 16	Grass Vigor 1/ May 17	Yield 2/ A&G	Yield 2/ alfalfa	Yield 2/ Grass
1. Check (with 5/ Fertilizer)	Fall 3/		0	0	0	0	0	0	1.18	0.41	0.77
	Spring		0	0	0	0	0	0	1.05	0.37	0.68
2. Diuron (Karmex)	Fall	0.75	100	100	10	0	53	0	1.27	.24	1.04
	Spring		60	70	0	0	0	0	1.20	.36	.88
3. Diuron (Karmex on fertilizer	Fall	0.75	93	100	3	0	0	0	1.25	.26	.84
	Spring		27	53	33	33	0	0	1.24	.28	.96
4. Diuron (Karmex)	Fall	1.5	100	100	17	7	53	53	.83	.50	.34
	Spring		60	0	3	0	0	0	.98	.40	.66
5. Simazine (Princep)	Fall	1.0	100	100	3	0	0	0	1.23	.50	.73
	Spring		87	100	3	0	0	0	1.13	.33	.80
6. Simazine (Princep)	Fall	1.5	100	100	3	10	43	50	.57	.31	.26
	Spring		93	100	0	0	0	0	1.12	.32	.80
7. CIPC	Fall	1.0	100	100	0	0	3	0	1.13	.27	.87
	Spring		60	100	0	0	0	0	1.37	.34	1.04
8. CIPC	Fall	2.0	100	100	7	0	10	0	1.31	.31	1.00
	Spring		67	83	0	0	0	0	1.17	.41	.76
9. CIPC on Fertilizer	Fall	1.0	100	100	0	0	0	0	1.24	.37	.87
	Spring		43	83	0	0	0	0	1.17	.41	.76
10. CIPC Granular	Fall	1.0	63	90	0	0	0	0	1.05	.31	.74
	Spring		30	0	3	0	0	0	.88	.38	.50
11. CIPC Granular	Fall	2.0	10	100	3	0	7	0	1.09	.26	.83
	Spring		33	53	0	0	3	0	1.25	.35	1.00
12. Dinitro	Fall	1.0	60	100	3	0	0	0	1.36	.66	.70
	Spring		53	47	3	0	0	0	1.38	.26	1.11
13. Dinitro	Fall	2.0	83	87	3	0	0	0	1.20	.14	1.07
	Spring		53	40	-	0	0	0	1.12	.40	.72
14. Dinitro + CIPC	Fall	1.0 + 1.0	100	100	0	0	10	0	1.27	.30	1.40
	Spring		60	80	33	33	7	0 +	1.04	.39	.64

Table 2 (cont'd). Washington County chickweed control in established dormant alfalfa.

Herbicide[5]	Time of Year	lb/A	Ratings: % Chickweed Kill[1] April 16	% Chickweed Kill[1] May 17	% Alfalfa Vigor Reduction[1] April 16	% Alfalfa Vigor Reduction[1] May 17	Grass Vigor[1] April 16	Grass Vigor[1] May 17	Yield (T/A) A&G[2]	Yield (T/A) Alfalfa	Yield (T/A) Grass
15. CIPC + Sevin	Fall[3]	2.0+1.0	100	100	7	0	3	0	.76	.13	.63
	Spring[4]		90	90	0	0	0	0	1.07	.39	.69
16.Dichlobenil (Casoran) Granular	Fall	1.0	97	77	30	0	57	0	.90	.33	.67
	Spring		57	33	27	0	17	0	1.11	.14*	1.00
17.Terbacil (Sinbar)	Fall	0.4	100	100	3	7	27	10	.73*	.34	.41
	Spring		100	100	7	10	50	33	.61*	.43	.18*
18.Terbacil	Fall	0.8	100	100	13	13	63	90	.56*	.43	.13*
	Spring		100	100	7	20	30	57	.54*	.41	.14*
19.Diuron + Terbacil	Fall	0.75+0.4	100	100	13	13	30	43	.53*	.24	.31
	Spring		100	100	3	7	47	33	.85	.45	.40
20.Dicamba (Bandel-D)	Fall	0.25	100	100	50	20	0	0			
	Spring		100	100	60	40	3	0			
21.Dicamba (Bandel-D)	Fall	0.5	100	100	97	50	3	0			
	Spring		100	100	97	73	3	0			
22.Dicamba	Fall	0.75	100	100	97	87	7	0			
	Spring		100	100	100	100	3	0			
23. Dicamba	Fall	1.0	100	100	100	100	10	0			
	Spring		100	100	100	100	7	0			
								*$LSD_{0.05}$ =	.36	.26	.56

1/ 0 = no effect on crop (alfalfa and grass) and weed.
100 = 100% kill of weeds or 100% reduction in vigor or height of crop.

2/ A&G = total alfalfa and grass yields for 1st harvest.

3/ Fall application made in mid-December, 1967.

4/ Spring application made on March 25, 1968.

5/ Fertilizer applied on all plots at 500 lb/A of 0-15-30.

Ken Wisner, Cooperator

Table 2 (cont'd). Washington County chickweed control in established dormant alfalfa.

Herbicide 1/	Time of Year	lb/A	% chickweed kill 1/ April 16	% chickweed kill 1/ May 17	% alfalfa vigor reduction 1/ April 16	% alfalfa vigor reduction 1/ May 17	Grass vigor 1/ May 17	Yield (T/A) 2/ Alfalfa	Yield (T/A) 2/ Grass	Yield (T/A) 2/ Total
15. CIPC +	Fall 3/	2.0+1.0	100	100	7	0	3	0	.76	.13	.89
Sevin	Spring 4/		90	90	0	0	0	0	1.07	.39	.89
16.Dichlobenil (Casoron)	Fall	1.0	97	77	30	0	57	0	.90	.33	.67
Cranular	Spring		57	33	27	0	17	0	0.11	.14*	1.00
17.Terbacil (Sinbar)	Fall	0.4	100	100	3	7	27	10	.71*	.34	.41
	Spring		100	100	7	10	50	33	.61*	.43	.18*
18.Terbacil	Fall	0.8	100	100	13	13	63	90	.56*	.43	.13*
	Spring		100	100	7	20	30	57	.54*	.41	.14*
19.Diuron + Terbacil	Fall	0.75+0.4	100	100	13	13	30	43	.51*	.24	.31
	Spring		100	100	3	7	47	33	.85	.45	.40
20.Dicamba (Banvel-D)	Fall	0.25	100	100	50	20	0	0			
	Spring		100	100	60	40	3	0			
21.Dicamba (Banvel-D)	Fall	0.5	100	100	97	50	3	0			
	Spring		100	100	97	73	3	0			
22.Dicamba	Fall	0.75	100	100	97	87	7	0			
	Spring		100	100	100	100	3	0			
23. Dicamba	Fall	1.0	100	100	100	100	10	0			
	Spring		100	100	100	100	7	0			

*LSD 0.05 = .36 .26 .56

1/ 0 = no effect on crop (alfalfa and grass) and weed.
100 = 100% kill of weeds or 100% reduction in vigor or height of crop.

2/ Avg = total alfalfa and grass yields for 1st harvest.

3/ Fall application made in mid-December, 1967.

4/ Spring application made on March 25, 1968.

5/ Fertilizer applied on all plots at 300 lb/A of 0-13-30.

Ken Wisner, Cooperator

Canada Thistle Control in Corn

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Canada thistle infestations are increasing rapidly in cultivated crops. Many of our cultural practices have encouraged the spread of this noxious weed.

The objective of the investigation was to evaluate several herbicides for the control of Canada thistle (Cirsium arvense) in a growing corn crop.

Procedure

In 1968 a heavily infested Canada thistle area was selected for experimental plots. A randomized complete block was replicated four times. Treatments are listed in Table 1. Preplow treatments were made on 6 inch thistles on May 13. The land was plowed seven days following the preplow treatment and planted to corn on May 22. Preemergence and postemergence treatments were applied on May 13 and July 2, respectively. Canada thistle was harvested August 14, and percent control based on harvested thistle weights. Corn yields were not taken.

In addition percent weed control was rated visually from 0 to 100. A rating of 70 or higher is equivalent to commercially acceptable control and weeds could be removed by cultivation at that stage of growth. Percent vigor reduction was rated from 0 to 100; a rating of 0 equalled no vigor reduction.

A similar study at another site was initiated in 1967, and residual thistle control was estimated by visual ratings in August, 1968.

Results

Control resulting from atrazine and Amitrol-T preplow on actively growing foliages was similar three months after preplow applications (Table 1); thistle control at 2 lb/A was approximately 50% for Amitrol-T or atrazine and at 4 lb/A control was 62% for Amitrol-T and 65% for atrazine.

The addition of oil plus 2,4-D to atrazine as a preplow treatment increased control by about 10% when compared to atrazine alone preplow. A preplow treatment of 2,4-D resulted in 25% control; whereas, 2,4-D + oil doubled control.

Control of thistle by atrazine preemergence was 60 and 80% for 2 and 4 lb/A, respectively. As a postemergence treatment atrazine control was 84 and 88% at 2 and 4 lb/A, respectively.

Residue control from a 1967 preplow application of Amitrol-T or atrazine was estimated by visual ratings on August 14, 1968 (see Table 2). Atrazine preplow and postemergence at 4 lb/A resulted in over 90% residual control and Amitrol-T preplow was quite similar. Atrazine preemergence resulted in inferior control at 2 lb/A, but 4 lb/A resulted in 78.3% residual control.

Summary

Canada thistle control by atrazine preplow was similar to Amitrol-T which is a standard Canada thistle herbicide. Control was excellent at the 1967 site as a preplow atrazine treatment, but atrazine fell short of acceptable weed control as a preplow treatment at the 1968 site. However, atrazine preemergence and postemergence performed quite well in 1968. It seems logical that a combination of atrazine preplow plus an early postemergence treatment of atrazine should control Canada thistle.

Table 1. Canada thistle plots on the Jacob Diller Farm, Washington County, 1968.

Treatment	Time of Application	lb/A	July 2, 1968		Aug. 4, 1968
			% control[1] Canada Thistle	% Vigor[2] Reduction Canada Thistle	% control[3] Canada Thistle
1. Control			15	0	--
2. Atrazine	preplow	4	74	68	65.8
3. Atrazine	preplow	2	49	58	52.9
4. Atrazine	preplow	2	66	58	60.0
5. Atrazine	preplow	4	89	80	80.8
6. Atrazine	postplow	2	0	5	84.1
7. Atrazine	postplow	4	0	0	87.8
8. Atrazine + oil 2 gal/A	preplow	2	3	32	7.2
9. Atrazine + oil 2 gal/A	preplow	4	66	70	81.5
10. Atrazine + oil 2 gal/A + 2,4-D (ester)	preplow	2+¼	70	60	63.7
11. Atrazine + oil 2 gal/A + 2,4-D (ester)	preplow	4+¼	71	68	78.1
12. 2,4-D	preplow	¼	42	42	25.5
13. 2,4-D + oil	preplow	¼	38	38	49.9
14. Amitrol-T	preplow	2	61	40	47.2
15. Amitrol-T	preplow	4	72	62	62.0

[1] Visual rating.

[2] 100 = completely vigorous plant; 0 = no plant growth.

[3] Canada thistle was harvested and weights of control divided into treatment weights and this dividend subtracted from 100 to give % control.

Table 2. Canada thistle control applied in 1967, Warrenfeltz Farm, Washington County.

Treatment	lb/A	9/67 % Control[1] Canada Thistle	8/14/68 % Control[2] Canada Thistle
1. Control		0	0
2. Amitrol-T (preplow)	2	99.0	87.5
3. Amitrol-T (preplow)	4	98.1	90.2
4. Atrazine preplow	2	96.5	97.0
5. Atrazine preplow	4	98.1	92.8
6. Atrazine preemergence	2	49.1	30.0
7. Atrazine preemergence	4	76.4	78.3
8. Atrazine post	2	79.3	79.8
9. Atrazine post	4	76.8	91.8

[1]Plots were harvested and hand-separated. The control plot weight was divided into the treatment weights and subtracted from 100 to give % control.

[2]Visual rating 0 = no effect; 100 = 100% kill.

*Plot yield index 0 = no effect; 100 = 100% kill.

The treatment weights and subscripted from 100 to give % control.

Plots were harvested and hand-segregated. The control plot weight was divided into

| Treatment | Rate lb/A | Canada Thistle | % Control | Canada Thistle | % Control | Canada Thistle | % Control

Herbicides and Combinations for Weed Control in Soybeans

J. V. Parochetti
Department of Agronomy

Purpose and Objective

The objective of this study was to determine the effect of soybean yields following the applications of preplant incorporated or preemergence herbicides plus a postemergence herbicide, chloroxuron (TENORAN).

Procedure

At the Worcester County Vocational High School two studies were conducted. Trifluralin (TREFLAN), nitralin (PLANAVIN), and vernolate (VENOLALE) at 3/4, 3/4 and 3 lb/A, respectively were preplant incorporated (ppi) on May 23. Linuron (LOROX) was surface applied on May 23. The Dare variety of soybeans was planted on June 1. Chloroxuron (TENORAN) was applied postemergence when soybeans were in the first true trifoliate leaf stage at 1½ and 3 lb/A on June 1; ½% Adjuvan-T V:V was used only at the 1½ lb/A rate. The ppi and preemergence treatments were applied alone and in combination with the postemergence treatments. No cultivation was employed.

In an adjacent area trifluralin as an emulsifiable concentrate and nitralin as a wettable powder and as a water dispersable liquid were preplant incorporated at 3/4, 1 and 1½ lb/A. Dates of treatment and planting are similar to the first study described. Weeds were counted on June 20 and the plots cultivated to eliminate weed competition.

Results

Of the two studies conducted on soybeans at the Worcester County site, the first study was not cultivated, and it had a serious infestation of ragweed which drastically reduced yields (Table 1). Excellent grassy weed

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Results

Of the two studies conducted on soybeans at the Worcester County Site, the first study was not cultivated, and it had a serious infestation of ragweed which drastically reduced yields (Table I). Excellent grassy weed

control was obtained with all treatments except chloroxuron. Ragweed was controlled by linuron and chloroxuron used alone; all other herbicides failed to control ragweed. More soybean injury was recorded with 1½ lb/A chloroxuron plus Adjuvan-T than with 3 lb/A of only chloroxuron. The combination of trifluralin, nitralin, or vernolate plus chloroxuron resulted in excellent weed control, with no yield reductions (30 to 34 bu/A) inspite of serious soybean injury from chloroxuron. The only herbicide to perform well without chloroxuron was linuron; soybean yields were 32.8 bu/A.

The second and adjacent experiment was clean cultivated, but early weeds counted before cultivation.

Trifluralin at 3/4 lb/A was similar to 1 lb/A of nitralin for giant foxtail control (Table 2). No differences were noted between the nitralin formulations. No significant yield reductions were found from the cultivated check which yielded 34.7 bu/A, indicating that the herbicides are not affecting soybean yields.

Summary

Chloroxuron postemergence effectively controlled ragweed which escaped trifluralin, nitralin, and vernolate. Soybean yields were not significantly reduced by chloroxuron in combination with the preplant incorporated or preemergence herbicides studied. Soybean yields were significantly lower when chloroxuron was used alone at 1.5 lb/A plus ½% Adjuvan-T. This reduction was attributed to the poorer weed control because the yields from the 3 lb/A rate of chloroxuron were significantly higher.

Soybean yields in clean cultivated plots were not reduced as a result of trifluralin or nitralin treatments.

Table 1. Preplant and preemergence herbicides plus chloroxuron (Tenoran) on soybeans, Snow Hill, Maryland, 1968.

Treatment	lb/A	% Control					
		Grass		Ragweed		Morning Glory	
		7/5	8/10	7/5	8/10	7/5	8/10
1. Control		0	17	0	0	0	13
2. Trifluralin (Treflan) ppi	3/4	93	94	8	0	87	33
3. Nitralin (Planavin) wp ppi	3/4	80	87	0	10	65	53
4. Linuron (Lorox) pre	3/4	85	90	98	97	37	87
5. Vernolate (Vernam) ppi	3	81	97	32	67	52	43
6. Chloroxuron (Tenoran) + ½% Adjuvan-T post	1½	40	23	98	97	93	95
7. Chloroxuron without Adjuvan-T post	3	52	20	97	97	95	87
8. Trifluralin (Treflan) ppi + Chloroxuron (Tenoran) post + ½% Adjuvan-T post	3/4 1.5	94	96	92	78	98	93
9. Nitralin (Planavin) wp ppi + Chloroxuron (Tenoran) post + ½% Adjuvan-T	3/4 1.5	75	70	97	88	95	82
10. Linuron (Lorox) pre + Chloroxuron (Tenoran) post	3/4 1.5	97	96	100	100	93	80
11. Vernolate (Vernam) ppi + Chloroxuron (Tenoran) post + ½% Adjuvan-T	3 1.5	99	99	100	99	93	75
12. Trifluralin (Treflan) ppi + Chloroxuron (Tenoran) post	3/4 3	88	73	100	92	98	100
13. Linuron (Lorox) pre + Chloroxuron (Tenoran) post	3/4 3	96	88	100	93	95	92
14. Vernolate (Vernam) ppi + Chloroxuron (Tenoran) post	3 3	98	93	100	95	99	87

Table 1. Preplant and preemergence herbicides plus chloroxuron (Tenoran) on soybeans, Snow Hill, Maryland, 1968. (Continued)

Treatment	lb/A	% Control		Soybeans			Yield Bu/A
		Smartweed 7/5	Pigweed 7/5	Kill 7/5	Vigor Reduction 7/5	8/10	
1. Control		0	0	0	0	0	7.5
2. Trifluralin (Treflan) ppi	3/4	93	100	7	3	0	5.3
3. Nitralin (Planavin) wp ppi	3/4	23	100	0	0	0	7.4
4. Linuron (Lorox) pre	3/4	97	100	0	0	0	32.8
5. Vernolate (Vernam) ppi	3	100	100	0	0	0	10.7
6. Chloroxuron (Tenoran) + ½% Adjuvan-T post	1½	100	100	12	35	13	15.8
7. Chloroxuron without Adjuvan-T post	3	97	100	0	17	7	29.9
8. Trifluralin (Treflan) ppi + Chloroxuron (Tenoran) post + ½% Adjuvan-T post	3/4 1.5	98	100	33	30	18	26.7
9. Nitralin (Planavin) wp ppi + Chloroxuron (Tenoran) post + ½% Adjuvan-T	3/4 1.5	98	100	3	20	3	32.8
10. Linuron (Lorox) pre + Chloroxuron (Tenoran) post	3/4 1.5	100	100	40	30	23	30.9
11. Vernolate (Vernam) ppi + Chloroxuron (Tenoran) post + ½% Adjuvan-T	3 1.5	100	100	12	35	22	34.8
12. Trifluralin (Treflan) ppi + Chloroxuron (Tenoran) post	3/4 3	100	100	40	20	10	31.5
13. Linuron (Lorox) pre + Chloroxuron (Tenoran) post	3/4 3	100	100	7	18	12	34.1
14. Vernolate (Vernam) ppi + Chloroxuron (Tenoran) post	3 3	100	100	17	33	17	30.2
					LSD 0.05 =		12.6
					LSD 0.01 =		16.8

Table 2. Trifluralin and nitralin (PLANAVIN) on soybeans, Snow Hill, 1968.

Treatment	Time of Application	lb/A	% control 6/20[1] Giant Foxtail	% control 6/20[1] Ragweed	Yield Bu/A
1. Control			(41)[2]	(91)[3]	34.7
2. Trifluralin (Treflan)	ppi	3/4	94.7	43.6	34.2
3. "	ppi	1	88.6	43.3	35.8
4. "	ppi	1½	74.1	52.1	30.3
5. Nitralin (Planavin) wp	ppi	3/4	66.1	28.0	34.7
6. "	ppi	1	93.0	34.2	31.3
7. "	ppi	1½	91.2	67.3	34.1
8. Nitralin (Planavin) wdl[4]	ppi	3/4	60.1	48.7	32.5
9. "	ppi	1	71.5	57.8	30.4
10. "	ppi	1½	92.0	51.4	30.2
				LSD 0.05 =	5.2
				LSD 0.01 =	7.0

[1]All plots were clean cultivated 2 times after weed counts.

[2]no. of weeds per 4 ft.[2]

[3]no. of weeds per 13.5 ft.[2]

[4]wdl - water dispersable liquid.

Table 2. Trifluralin and nitralin (PLANAVIN) on soybeans, Snow Hill, 1969.

Treatment	Application	Time of	lb/A	% control 6/20[1] Plant Foxtail	Reduced	Yield Bu/A
1. Control				(61)[2]	(91)[3]	34.7
2. Trifluralin (Treflan)	ppi		3/4	94.7	43.6	34.2
3. "	ppi		1	88.6	43.3	35.8
4. "	ppi		1½	74.1	52.1	33.3
5. Nitralin (Planavin) wp	ppi		3/4	66.1	28.0	34.7
6. "	ppi		1	83.0	34.2	31.3
7. "	ppi		1½	91.2	67.3	34.1
8. Nitralin (Planavin) wdl[4]	ppi		3/4	60.1	48.7	32.5
9. "	ppi		1	71.5	57.8	30.4
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The Volatility of Trifluralin (TREFLAN), Benefin (BALAN), and Nitralin (PLANAVIN)

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

Trifluralin (TREFLAN), benefin (BALAN), and nitralin (PLANAVIN) generally result in better weed control when incorporated than when applied as a surface spray. One factor attributed to the need for incorporation is to reduce vapor losses of these herbicides. The purpose of this investigation was to study the volatility of trifluralin, benefin, and nitralin, three structurally related herbicides, from a spray and granular formulation.

Procedure

The volatility of trifluralin, benefin, and nitralin was studied under controlled laboratory conditions. Air was passed through chambers containing soil treated with herbicide and then passed through Florisil columns which absorbed the herbicide vapors. After being treated, samples were enclosed in jars (chambers) and had air pumped through at the rate of 1.5 cubic feet/hours. The exhaust port on the sample jars led to the Florisil trap in which the herbicide vapors were trapped.

The sample dishes used in the investigation had an area of 3.55 sq. in. and contained 60 g. of Lakeland loamy sand. To study the effects of various soil types on volatility, tests were also run on Hagerstown clay loam and Sharky clay. Soil characteristics are listed in Table 1.

Two lb./A of herbicide at 125 gpa was sprayed on the soil surface. Trifluralin and benefin samples were from the emulsifiable concentrates, 4 lb./gal. and 1.5 lb./gal. respectively. A 75% wettable powder formulation was used for nitralin. Granular formulations were trifluralin 5% and benefin 2.5% each on a celatom carrier and nitralin 3%.

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The sample dishes used in the investigation had an area of 3.55 sq. in. and contained 60 g. of Lakeland loamy sand. To study the effects of various soil types on volatility, tests were also run on Hagerstown clay loam and Sharkey clay. Soil characteristics are listed in Table I.

Two lb./A of herbicide at 12% ppe was sprayed on the soil surface. Trifluralin and benefin samples were from the emulsifiable concentrates, 4 lb./gal. and 1.5 lb./gal. respectively. A 75% wettable powder formulation was used for nitralin. Granular formulations were trifluralin 5% and benefin 2.5% each on a celatom carrier and nitralin 3%.

Results

Very little nitralin vapor losses were detected at 50C from a Lakeland loamy sand at field capacity whereas 24.5% and 12% of trifluralin and benefin, respectively, were lost as vapors. (Figures 1 and 2). Volatility of trifluralin and benefin increased linearly with increasing temperatures of 30, 40, and 50C (Figure 3). Volatility increased rapidly as the soil moisture level increased from air dryness to field capacity, but failed to increase markedly above field capacity (Figures 1 and 2). Volatility decreased as the cation exchange capacity increased (Figure 4). The order of volatility from field capacity soils is as follows: Lakeland loamy sand is greater than Hagerstown clay loam which is greater than Sharkey clay (Figure 4). Vapor losses from granular benefin were similar to the spray applications at 30 and 40C (Figure 5 vs. Figure 2). Volatility of trifluralin from granules was reduced approximately one-third over the spray application at 40C, and approximately one-half at 30C (Figure 5 vs. Figure 1).

Summary

Volatility of sprayed application of trifluralin was approximately twice that of benefin under the conditions described whereas nitralin volatility was negligible. Decreasing soil cation exchange capacity and increasing soil moisture increased volatility.

A granular formulation of trifluralin was effective in reducing vapor losses, but volatility of a granular formulation of benefin was similar to the spray application.

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Table 1. Characteristics of soil used in volatility studies.

Soil type	pH	% Organic matter	CEC (me/100g soil)	Mechanical analysis percent		
				Sand	Silt	Clay
Lakeland loamy sand	6.2	0.5	2.9	89.2	4.8	6.0
Hagerstown clay loam	6.8	2.5	14.7	23.2	44.8	32.0
Sharkey clay	6.0	2.5	46.4	11.2	22.8	66.0

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Hagerstown clay loam	6.8	2.5	14.7	23.2	44.8	32.0
Sharkey clay	6.0	2.5	46.4	11.2	22.8	66.0

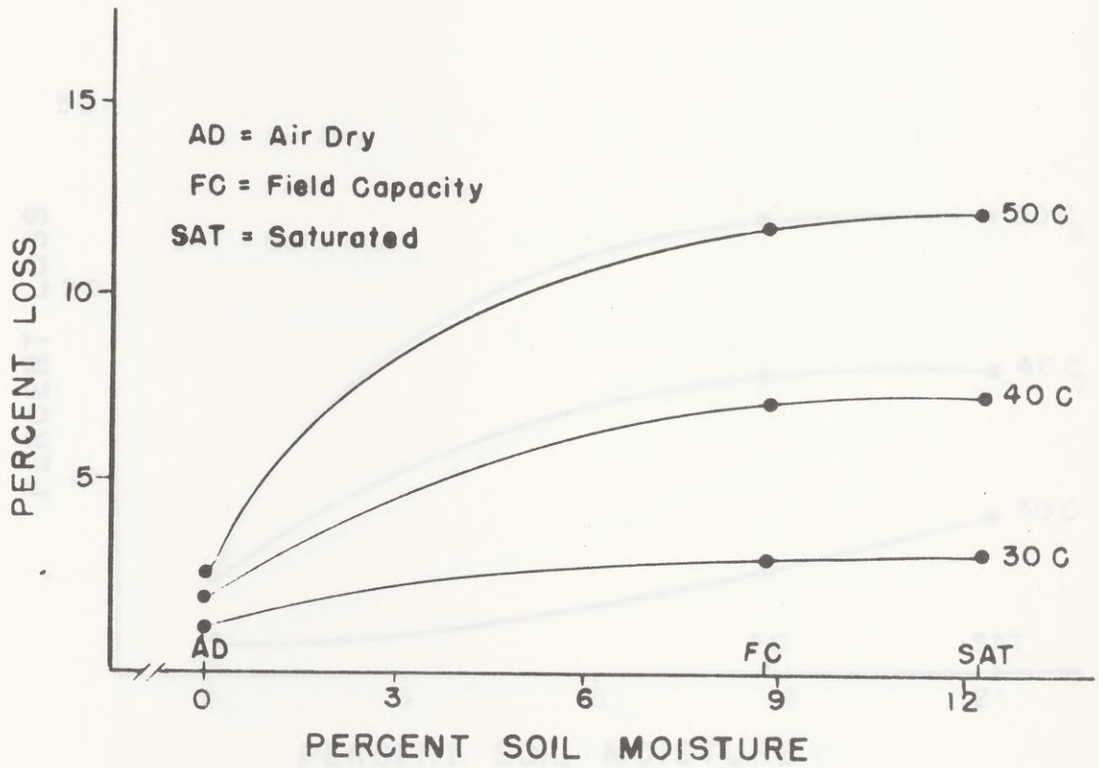


Figure 1. The effect of soil temperature and moisture on the volatility of trifluralin from Lakeland loamy sand at an air flow rate of 1.5 cu. ft/hr after 3 hours.

Figure 1. The effect of soil temperature and moisture on the volatility of ketlingralin from lakeland loamy sand at an air flow rate of 1.5 cm. ft/hr after 3 hours.

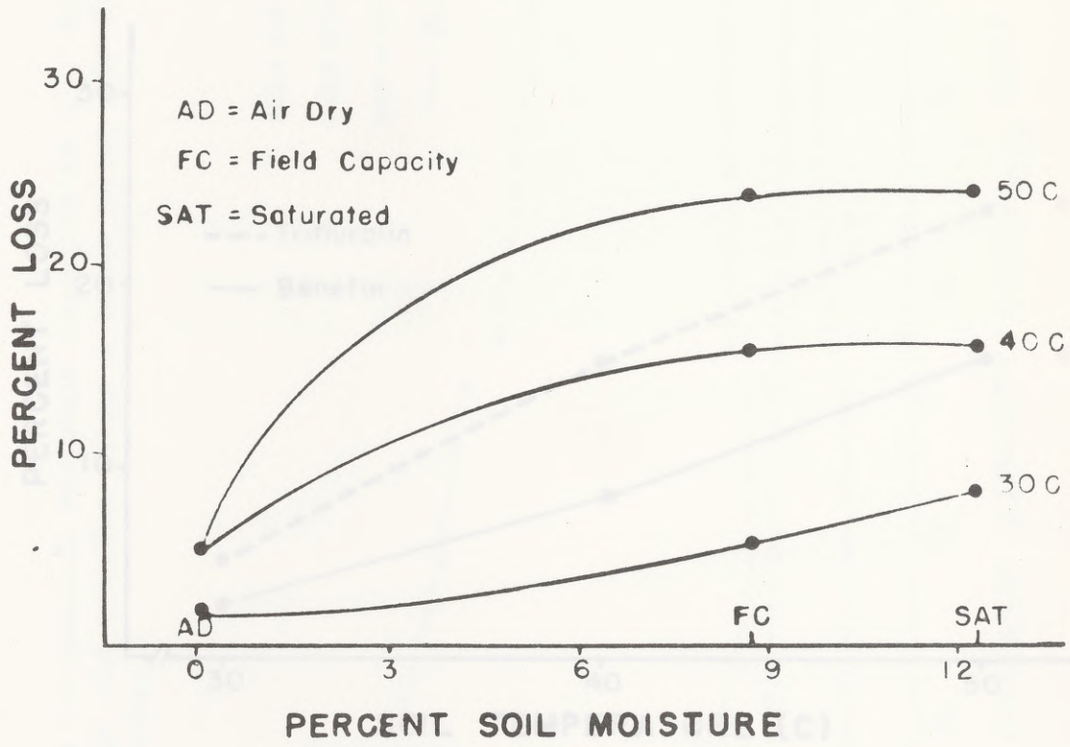
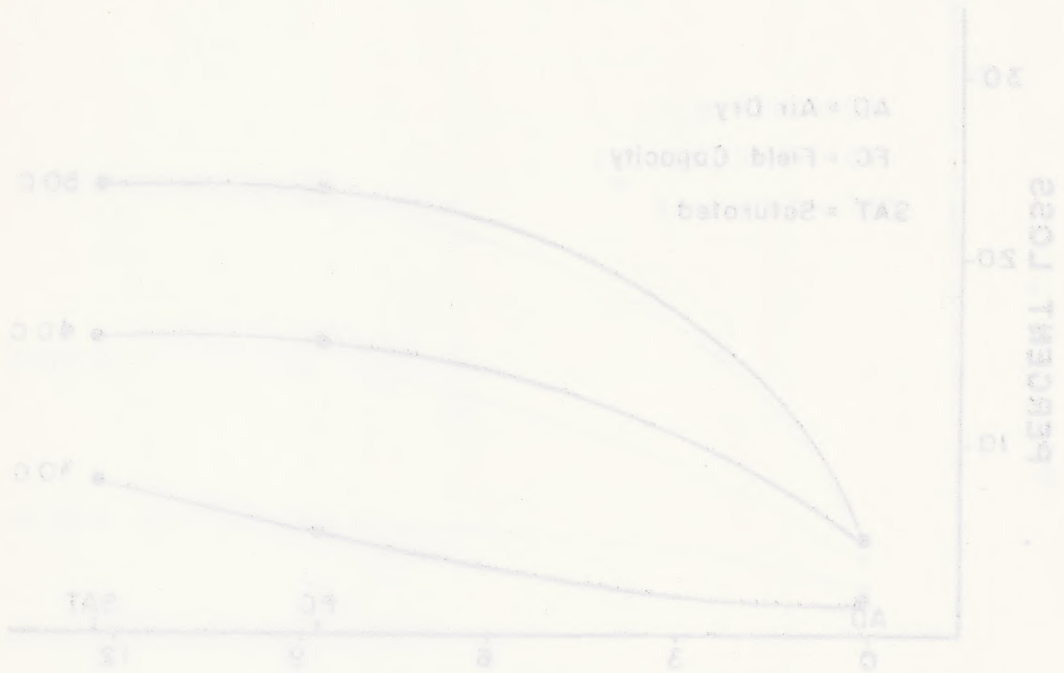


Figure 2. The effect of soil temperature and moisture on the volatility of benefin from Lakeland loamy sand at an air flow rate of 1.5 cu. ft/hr.



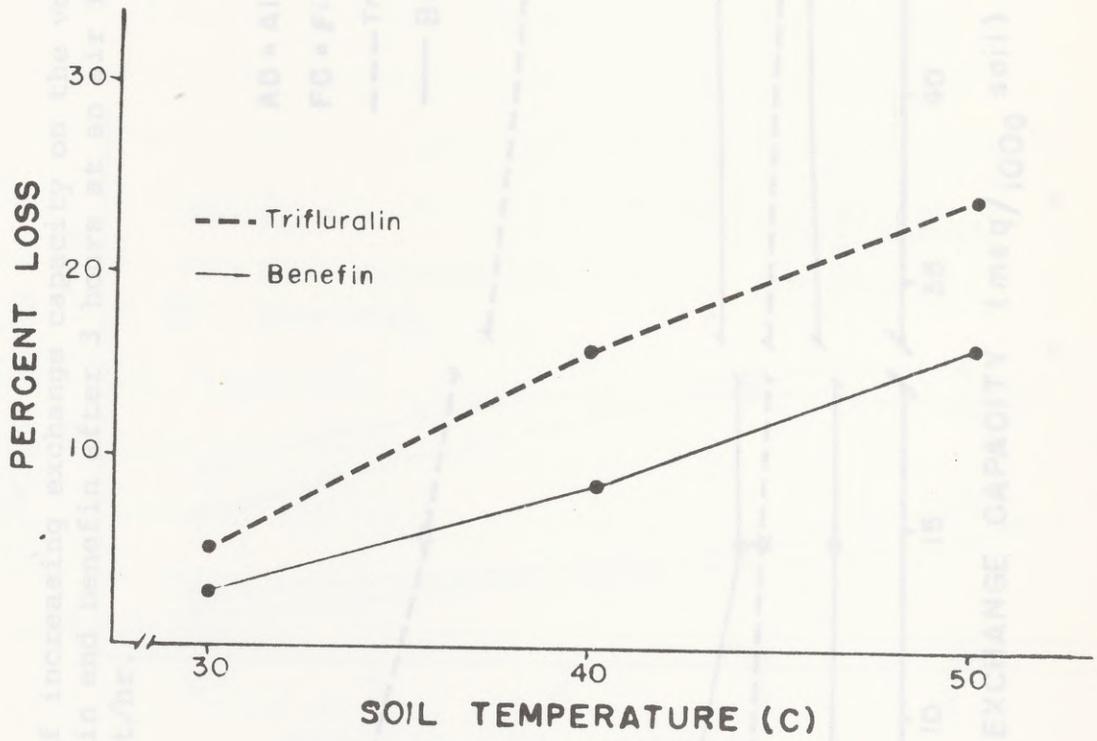


Figure 3. The effect of soil temperature on the volatility of trifluralin and benefin from field capacity Lakeland loamy sand soil.

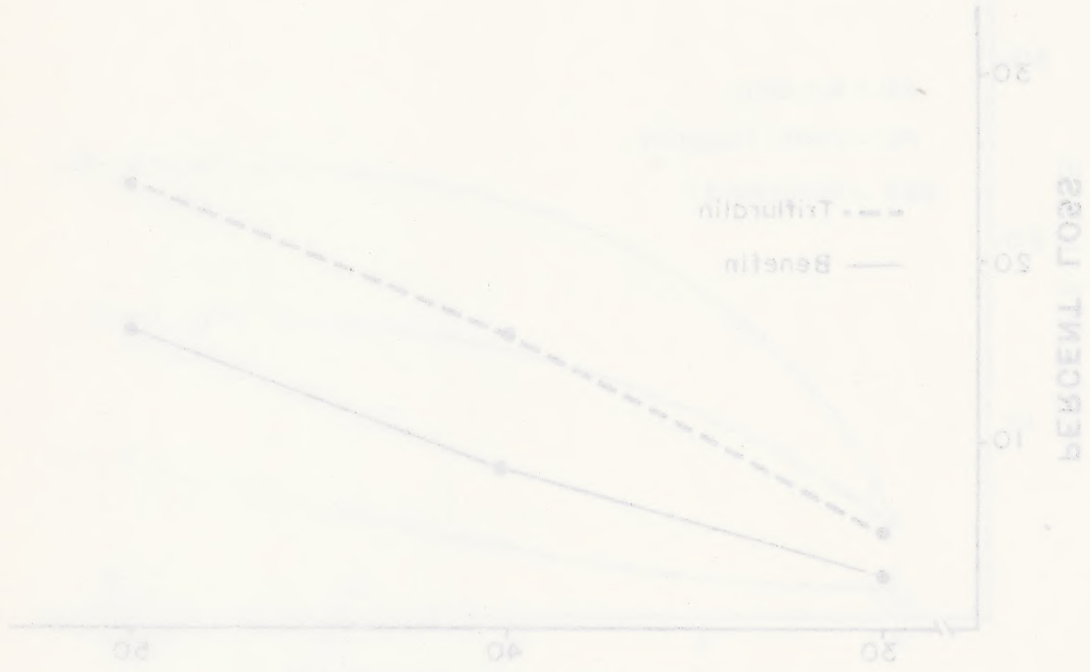
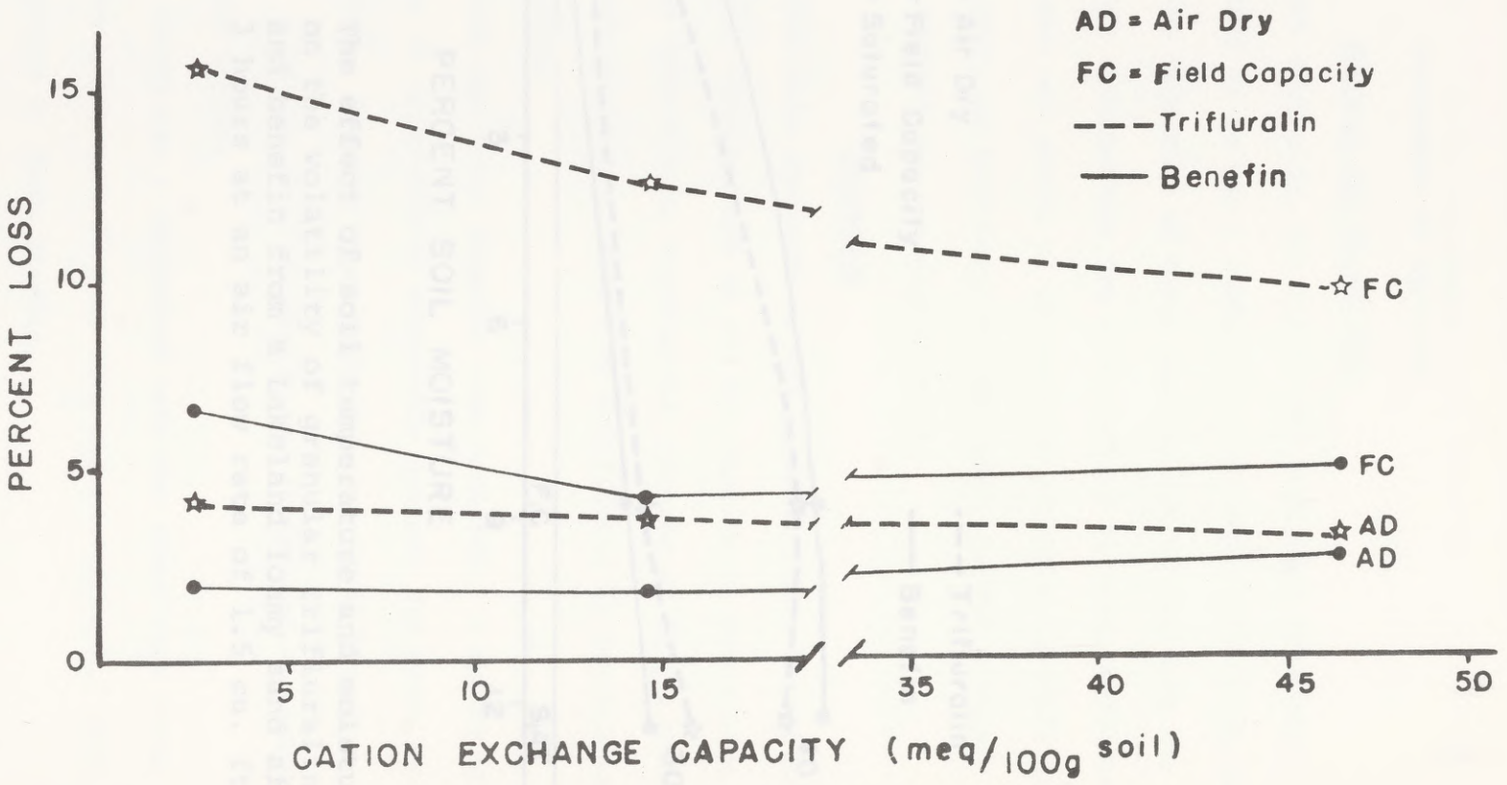
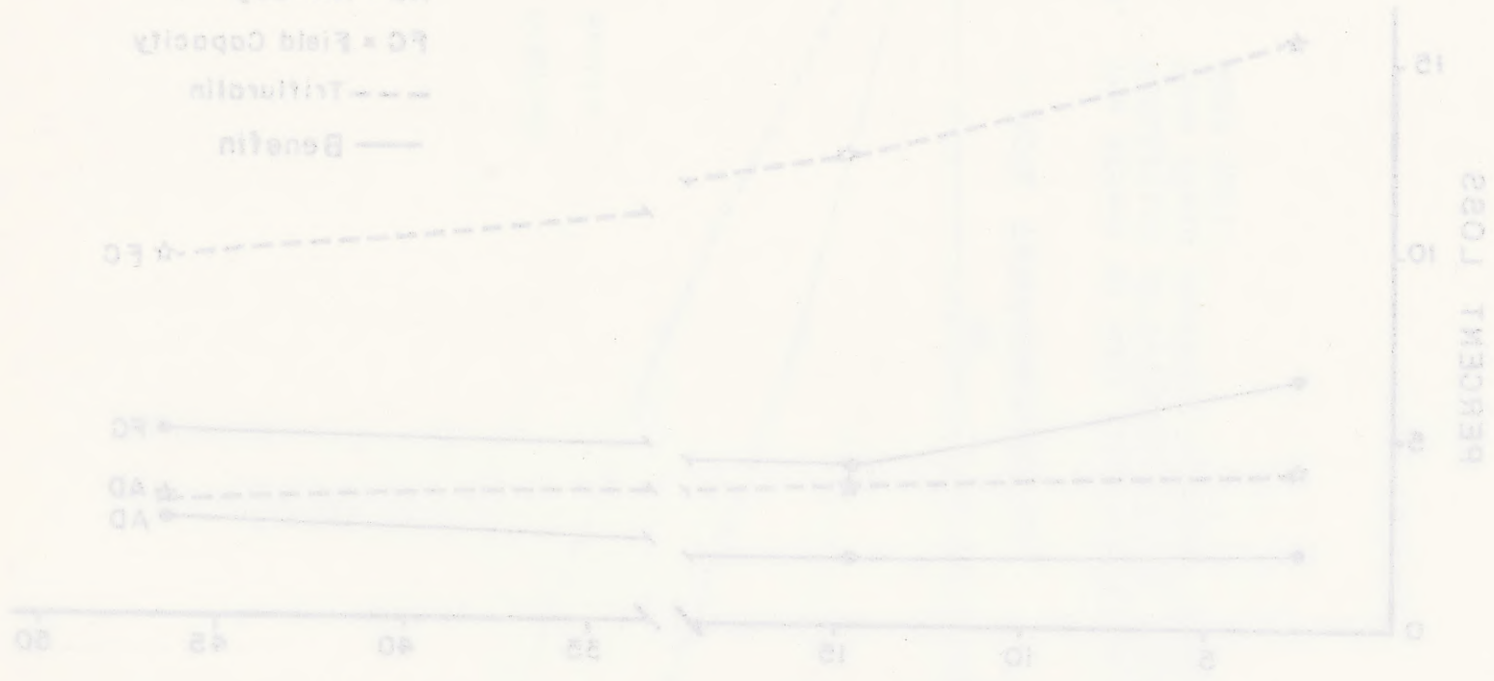


Figure 3. The effect of soil temperature on the volatility of trifluralin and benefin from field capacity Lakeland loamy sand soil.

Figure 4. The effect of increasing exchange capacity on the volatility of trifluralin and benefin after 3 hours at an air flow rate of 1.5 cu. ft/hr.





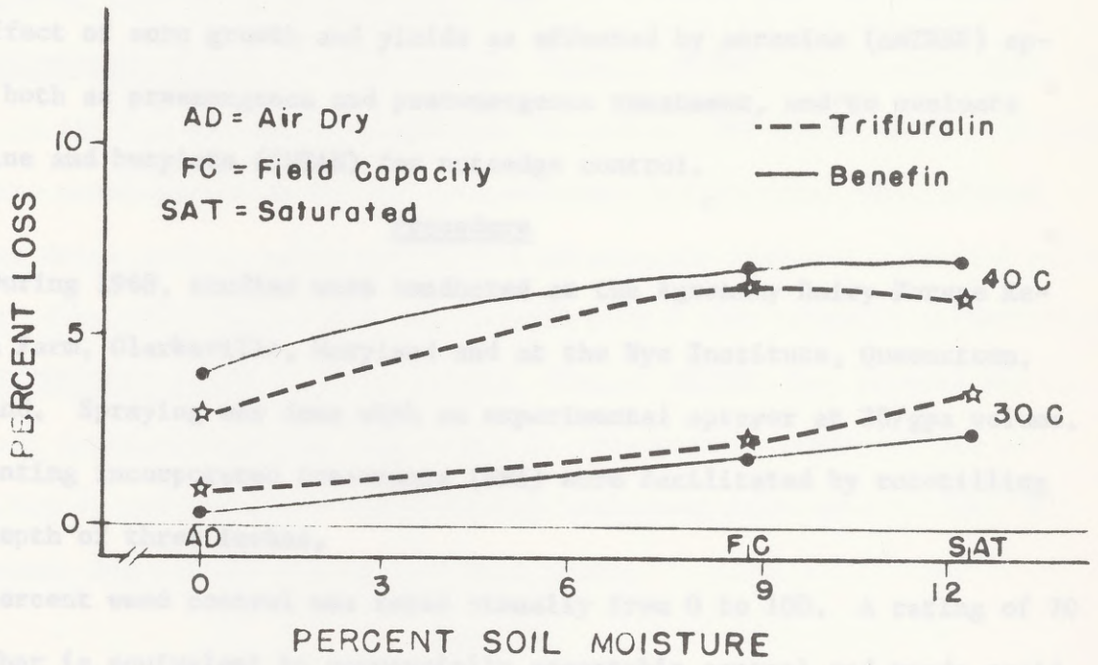


Figure 5. The effect of soil temperature and moisture on the volatility of granular trifluralin and benefin from a Lakeland loamy sand after 3 hours at an air flow rate of 1.5 cu. ft/hr.

Herbicides and Combinations for Weed Control in Corn

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Purpose and Objectives

There is no perfect herbicide, but one of the best ways to achieve near perfect weed control is to use a combination of herbicides which compliment each other. The objective of these studies was to evaluate new herbicides and herbicide combinations for weed control in corn, evaluate the effect of corn growth and yields as effected by atrazine (AATREX) applied both as preemergence and postemergence treatment, and to evaluate atrazine and butylate (SUTAN) for nutsedge control.

Procedure

During 1968, studies were conducted at the Agronomy Dairy Forage Research Farm, Clarksville, Maryland and at the Wye Institute, Queenstown, Maryland. Spraying was done with an experimental sprayer at 30/gpa volume. Preplanting incorporated treatments (PPI) were facilitated by rototilling to a depth of three inches.

Percent weed control was rated visually from 0 to 100. A rating of 70 or higher is equivalent to commercially acceptable control and weeds could be removed by cultivation. Percent vigor reduction was rated from 0 to 100% based on the control. A rating of 30 or higher was designated as commercially unacceptable crop injury.

The experimental design was a randomized complete block with three replications. Three row plots were 30 feet long and row width 2.5 feet. No cultivation was employed in these studies.

EXPERIMENT NUMBER 1. Corn hybrid, Pioneer MF3306, was planted on April 29, 1968, at the Wye Institute, Queenstown, Maryland and treated preemergence and preplant incorporated on May 2. Postemergence application was on June 5, to three inch tall grassy weeds.

EXPERIMENT NUMBER 2. Corn hybrid, Funk G-4473, was planted on June 5, 1968, at the Forage Research Farm, Clarksville, Maryland, and treated preemergence and preplant incorporated on June 6. Postemergence application was made on July 12 on 30 inch high corn.

EXPERIMENT NUMBER 3. Corn hybrid, Pioneer MF3306, was planted April 29, 1968, at the Wye Institute, Queenstown, Maryland. All plots received 2 lb/A atrazine preemergence on May 6. Postemergence applications were made at various dates with an additional 2 lb/A of atrazine with and without 2 gal/A Sun oil 11E. The control plot was treated with 2 lb/A atrazine preemergence.

EXPERIMENT NUMBER 4. Corn hybrid, Pioneer MF3306, was planted May 6. Preplant incorporation was done on May 6; preemergence treatment was applied May 7, and the first postemergence treatments were done on June 15. When used, Sun oil 11E was applied at 1 gal/A.

Results

EXPERIMENT NUMBER 1. CP 50144 was used in combination with several herbicides to provide acceptable weed control. Results on weed control and corn yields are reported in Table 1. CP 50144 preemergence at 1.5 lb/A and higher resulted in excellent giant foxtail (*Setaria faberii*) control throughout the season; whereas fall panicum (*Panicum dichotomiflorum*) was almost completely controlled at the low rate of 1 lb/A. CP 50144 was notably weak on lambsquarter (*Chenopodium alba*) and ragweed (*Ambrosia artemisiifolia*). CP 50144 postemergence with or without Sun oil 11E missed

weeds which were controlled by preemergence application; in contrast, ragweed control was 85% with a 2 lb/A application plus oil.

There was little giant foxtail control resulting from atrazine and linuron applied alone at low rates; however, 93% fall panicum control was recorded for 0.5 lb/A linuron.

At the rates studied, CP 50144 plus linuron resulted in an inferior giant foxtail control, but other weeds were adequately controlled including smartweed (Polygonum pensylvanicum).

The best combination which resulted in season long, full spectrum, weed control was 1.5 lb/A CP 50144 plus 1.0 lb/A atrazine. A combination of these two herbicides each at reduced rates, resulted in full spectrum weed control; whereas, alone at these rates some weeds were not controlled.

EXPERIMENT NUMBER 2. Results of an evaluation of herbicides and combinations at the Forage Research Farm in 1968 are presented in Table 2. Crabgrass (Digitaria sanguinalis) control on July 14 was 100% except for the control, 2,4-D preemergence (80%), and 2,4-D postemergence (33%). Pigweed (Amaranthus retroflexus) control, except for the check, was 85% or higher with all treatments on July 14. Pigweed control declined below 70% on August 26, for linuron (spray), propachlor, CP 50144, and linuron plus CP 50144.

Purslane (Portulaca oleracea) control was generally 80% or greater except for the control, 2,4-D postemergence (40%) and butylate (77%).

Nutsedge (Cyperus esculantus) was a late invader of the plots appearing one month following planting. Butylate and butylate plus atrazine were the only treatments which resulted in 90% or greater control. An unexpected and unexplainable reduction in corn yield was noted with atrazine (1 lb/A) plus butylate (3 lb/A).

A 23% reduction in corn vigor was noted from a granular application of linuron at 1 lb/A; however, a 1 lb/A linuron spray did not adversely affect corn vigor. Granular linuron plus propachlor reduced vigor 17% as compared to a 10% reduction with similar combination as the spray. These vigor reductions did not reduce yields.

EXPERIMENT NUMBER 3. Data for Experiment 3 are presented in Table 3. Data for total height of the corn on June 25, July 5, and September 23, height to the first ear on September 23, and yield were obtained. Only on July 5 was there a significant reduction in height with all treatments applied with oil, but no differences in height when oil was not used. The only other significant reduction in corn height was noted on September 23 to corn spray postemergence with 2 lb/A atrazine plus oil when the corn was 16 inches high. The tallest corn treated was 3 feet.

The only yield reduction that occurred was when 3 feet tall corn was sprayed with atrazine plus oil.

EXPERIMENT NUMBER 4. Numerous combinations of butylate plus atrazine were investigated; a total of 48 treatments including each herbicide alone and in combination were evaluated. Table 4 contains representative data for nutsedge (Cyperus esculantus) control. Butylate at 3 lb/A and 4 lb/A preplant incorporated (ppi) resulted in 78 and 86% control on July 5. Atrazine at 4 lb/A preplant incorporated was superior to a preemergence treatment. The addition of 1 gal/A Sun oil 11E to 2 lb/A atrazine postemergence increased nutsedge control 27%.

The only synergistic response to a combination of butylate and atrazine was the treatment of 3 lb/A butylate ppi plus 1 lb/A of atrazine postemergence. Other combinations were additive.

Summary

In corn, most of the herbicide combinations studied resulted in equal or better weed control when compared to these herbicides used alone at comparable rates. Linuron and many combinations with linuron resulted in corn vigor reduction on a clay loam soil at the Agronomy Dairy Forage Research Farm in 1968.

Increased spectrum weed control was observed with many of the herbicide combinations investigated in corn. Butylate and butylate plus atrazine were the only herbicides to result in 90% or higher nutsedge control at the Agronomy Dairy Forage Research Farm. This combination and other herbicides with CP 50144 (LASSO) were effective on fall panicum and lambsquarter. Butylate preplant incorporated plus atrazine postemergence was the only combination which was synergistic for nutsedge control at the Wye Institute; other combinations of butylate plus atrazine were additive.

Table 1. Evaluation of several herbicides and herbicide combination for weed control in corn at the Wye Institute, Queenstown, Maryland, 1968.

Treatment	Lb/A	% Weed Control, June 19				Oct. 2 % Weed Control		Yield
		Giant Foxtail	Lambsquarter	Smartweed	Ragweed	Giant Foxtail	Fall Panicum	Bu/A
Control	-	0	0	0	0	0	0	59.8
CP 50144 pre	1.0	58.5	73.6	96.8	0	56.7	96.7	92.6
CP 50144 pre	1.5	90.0	65.5	35.0	0	81.3	100.0	93.2
CP 50144 pre	2.0	88.5	57.5	94.4	23.5	92.7	100.0	126.6
CP 50144 pre	2.5	80.0	21.5	85.0	58.8	86.3	100.0	116.6
CP 50144 post	2.0	0	42.5	11.9	62.7	13.3	100.0	67.7
CP 50144 + 4 gal/A oil post	2.0	76.5	0	5.6	85.0	0	71.7	77.2
Atrazine pre	0.5	0	100.0	100.0	95.4	25.0	56.7	95.1
Atrazine pre	0.75	0	100.0	100.0	100.0	68.3	0	92.4
Atrazine pre	1.0	18.5	100.0	100.0	100.0	46.3	20.0	97.8
Linuron pre	0.5	0	100.0	98.3	78.4	15.0	93.0	79.0
Butylate ppi	2.0	61.5	91.9	55.6	0	20.0	100.0	89.9
CP 50144 + Atrazine pre	1.0+0.75	90.0	100.0	55.6	100.0	78.3	99.0	114.1
CP 50144 + Atrazine pre	0.75+0.5	93.5	100.0	100.0	100.0	86.3	75.0	135.3
CP 50144 + Atrazine pre	1.5+1.0	98.5	100.0	100.0	100.0	96.7	95.0	131.8
CP 50144 pre + Butylate ppi	1.0+2.0	96.5	69.0	46.2	32.7	83.3	100.0	127.4
CP 50144 pre + Butylate ppi	1.5+2.0	98.5	96.5	96.8	78.4	96.3	98.0	112.7
CP 50144 + Linuron pre	1.0+0.5	61.5	100.0	98.3	100.0	83.0	98.0	126.6
CP 50144 + Linuron pre	1.5+0.5	61.5	100.0	100.0	98.0	88.3	98.3	114.6

LSD 0.05 = 33.8

| | | |

Table 2. Evaluation of several herbicides and herbicide combinations for weed control in corn at the Forage Research Farm, Clarksville, Maryland, 1968.

Treatment	Lb/A	July 14 % vigor reduction corn	% Weed Control			Yield Bu/A
			July 14	Aug. 26		
			Purslane	Pigweed	Nutsedge	
Control pre	--	0	0	0	0	61.5
Atrazine pre	2	0	100.0	100.0	75.0	125.0
Linuron pre	1	3	100.0	58.0	83.0	94.4
Linuron (granular) pre	1	23	83.0	93.0	65.0	114.1
Propachlor pre	5	0	90.0	68.0	82.0	94.2
CP 50144 pre	2	0	100.0	65.0	75.0	98.9
Linuron + CP 50144 pre	1 + 1	10	100.0	37.0	58.0	85.9
Prometryne pre	2	7	100.0	98.0	75.0	96.3
Atrazine + Linuron pre	.5 + .5	3	100.0	100.0	57.0	81.9
Atrazine + Linuron pre	.75 + .75	0	100.0	100.0	75.0	90.6
Atrazine + Prometryne pre	1 + 1	0	100.0	97.0	55.0	89.9
Atrazine + Butylate pre	1 + 3	0	100.0	97.0	93.0	75.7
2,4-D pre	1	3	100.0	83.0	75.0	101.5
2,4-D post	1/2	0	100.0	95.0	37.0	75.8
Atrazine + CP 50144 pre	1 + 1	0	40.0	97.0	85.0	88.3
Atrazine + CP 50144 pre	1 + 1.5	3	100.0	93.0	52.0	93.9
Atrazine + Propachlor pre	1 + 3	3	100.0	97.0	87.0	103.7
Linuron + Propachlor pre	.875 + 1.75	10	98.0	96.0	60.0	90.4
Linuron + Propachlor (granular) pre	.875 + 1.75	17	100.0	87.0	50.0	98.9
Linuron + Butylate pre	.5 + 2	0	100.0	97.0	78.0	82.4
Linuron + Butylate pre	.5 + 1.5	0	100.0	97.0	71.0	100.8
Linuron + CP 50144 pre	.5 + 1.5	10	98.0	97.0	55.0	111.5
Butylate ppi	4	0	77.0	82.0	97.0	90.4
					LSD 0.05 =	26.8

Table 3. Postemergence effect of Atrazine on corn, Wye Institute, 1968.

Treatment[1]	Oil	Dates Treated	Height of corn	Corn Height (ft.) June 25	Corn Height (ft.) July 5	Sept. 23 Height(ft.)to tip of tassel	Sept. 23 Height to 1st ear(ft.)	Oct. 2 Yield Bu/A
1. Control		--	-	2.8	5.2	8.0	4.1	120
2. Atrazine	-	June 5	6"	3.2	5.0	7.8	4.2	132
3. Atrazine	+	"	"	2.5	4.6**	7.7	4.0	113
4. Atrazine	-	June 15	16"	3.1	5.2	7.9	4.2	121
5. Atrazine	+	"	"	2.5	4.7*	7.2*	3.8	117
6. Atrazine	-	June 25	3'	2.9	5.0	7.5	4.0	123
7. Atrazine	+	"	"	3.0	4.7*	7.7	3.9	102*
		*	LSD 0.05 =	0.6	0.4	0.6	0.4	17.0
		**	0.01 =	0.8	0.5	0.8	0.5	23.0

[1]All treatments, including the control received 2 lb/A Atrazine preemergence on May 6.

Table 4. The effect of atrazine, butylate and combinations on nutsedge at the Wye Institute, Queenstown, Maryland, 1968.

Treatment	Lb/A	Oil	Percent Control of Nutsedge Observed 7/5/68	Expected
1. Control	0	-	0	
2. Atrazine ppi	1	-	33	
3. Atrazine ppi	2	-	68	
4. Atrazine ppi	4	-	92	
5. Atrazine pre	2	-	62	
6. Atrazine pre	4	-	81	
7. Butylate ppi	2	-	68	
8. Butylate ppi	3	-	78	
9. Butylate ppi	4	-	86	
10. Atrazine post	1	-	30	
11. Atrazine post	2	-	65	
12. Atrazine post	4	-	86	
13. Atrazine post	1	+	55	
14. Atrazine post	2	+	92	
15. Atrazine post	4	+	97	
16. Butylate ppi	3	-		
+		+		
Atrazine post	1	-	96	84.6
17. Butylate ppi	3	-		
+		+		
Atrazine post	1	+	93	90.0
18. Atrazine ppi	1	-		
+		+		
Butylate ppi	3	-	80	85.3
19. Atrazine ppi	1	-		
+		+		
Butylate ppi	4	-	88	90.6
20. Atrazine ppi	2	-		
+		+		
Butylate ppi	3	-	95	93.0
21. Atrazine ppi	2			
+		+		
Butylate ppi	4	-	94	95.5
22. Atrazine ppi	2	-		
+		+		
Butylate ppi	2	-	83	89.8

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2. Atrazine ppi	1	-	33	
3. Atrazine ppi	2	-	68	
4. Atrazine ppi	4	-	92	
5. Atrazine pre	2	-	62	
6. Atrazine pre	4	-	81	
7. Butylate ppi	2	-	68	
8. Butylate ppi	3	-	78	
9. Butylate ppi	4	-	86	
10. Atrazine post	1	-	30	
11. Atrazine post	2	-	65	
12. Atrazine post	4	-	86	
13. Atrazine post	1	+	55	
14. Atrazine post	2	+	92	
15. Atrazine post	4	+	97	
16. Butylate ppi	3	-		
		+		
Atrazine post	1	-	96	86.6
17. Butylate ppi	3	-		
		+		
Atrazine post	1	+	93	90.0
18. Atrazine ppi	1	-		
		+		
Butylate ppi	3	-	80	85.3
19. Atrazine ppi	1	-		
		+		
Butylate ppi	4	-	88	90.6
20. Atrazine ppi	2	-		
		+		
Butylate ppi	3	-	95	93.0
21. Atrazine ppi	2	-		
		+		
Butylate ppi	4	-	94	95.5
22. Atrazine ppi	2	-		
		+		
Butylate ppi	2	-	83	89.8

The Control of Johnsongrass From Seed and Rhizomes

J. V. Parochetti
Department of Agronomy

Purpose and Objectives

The current research evaluates the effectiveness of different cultural and chemical methods for Johnsongrass control. Information was obtained on the type and intensity of cultural methods in relation to physiological changes of the rhizomes and the effect of a number of herbicides for the control of Johnsongrass.

Procedure

Four experiments were conducted in studying Johnsongrass control.

Experiment Number 1. A comparison of tillage equipment was evaluated for the control of rhizome Johnsongrass. A heavily-infested field of Johnsongrass at the Remington Farm, Chestertown, Maryland was kept fallow. Tillage was done 8 times between May 22 and September 10. Rhizomes were collected shortly after each tillage and the following data were collected for rhizomes: length, carbohydrates, and the percent survival. A randomized complete block was replicated 3 times.

Experiment Number 2. A heavily-infested Johnsongrass field near Princess Anne, Maryland was selected for a split plot experiment in which dalapon was applied preplow to actively growing Johnsongrass foliage on June 11, and either trifluralin or vernolate applied preplant incorporated June 21. Soybeans were planted June 28. The split plot was a comparison between two cultivations and no cultivation, replicated 3 times.

Experiment Number 3 and 4. A heavily-infested area of Johnsongrass, near Princess Anne, Maryland, was treated with a number of soil sterilants or foliar applied herbicides for rhizomous Johnsongrass control. Treatments and treatment dates are listed on Tables 3 and 4. The experiment was replicated 3 times.

Results

Experiment Number 1. Johnsongrass rhizomes were collected following each tillage throughout the summer of 1968 and were analyzed for total carbohydrates. The carbohydrates in the rhizomes decreased for all tillage practices investigated (Figure 1). The most effective tillage equipment was the rototiller. The spring tooth was next and then a disk. The rhizome lengths were reduced most effectively by rototilling (Figure 2). Disking reduced rhizome pieces somewhat, but a repeated spring toothing operation was not effective in reducing the rhizomes after the sixth tillage.

Between the eighth and ninth tillage, many of the rhizomes were dead. Less than 10 percent of the rhizomes collected after the ninth tillage were living (Table 1).

Experiment Number 2. Johnsongrass was effectively controlled in the same season in which a crop of soybeans was harvested. Dalapon alone resulted in about 50 percent control on October 10 (Table 2). Cultivation significantly decreased Johnsongrass on October 10 when dalapon and vernolate were used alone and when dalapon plus vernolate were used together. The most effective Johnsongrass control and the highest soybean yields were obtained with dalapon plus either vernolate or trifluralin and cultivation.

Experiment Number 3 and 4. A number of soil sterilants resulted in good Johnsongrass control. The percentage kill from the low rates of Pramitol, Altacide, and bromacil (Hyvar-X) 3 months after a June application, was 98, 85, and 89 percent, respectively. At the higher rates the percentage kill was 95 or greater (Table 3). Dalapon applied twice with a surfactant was more effective at 4 lb/A than at 7 or 10 lb/A; percent kill was

Results

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90, 77, and 65 percent for the lowest to the highest rates (Tables 3 and 4). MSMA applied at 3 lb/A twice each time to the same plot resulted in 98 percent kill (Table 4).

Dalapon plus Sun oil 11E (a crop oil) was similar to dalapon applied alone with a surfactant. Dalapon plus paraquat (4 + ½ lb/A) resulted in rapid top kill, but regrowth occurred (Table 4).

Summary

The spring tooth, rototiller or disk in repeated cultivation in fallow land resulted in greater than 90 percent Johnsongrass rhizome death by September after 9 tillages spread throughout the season. Rototilling was most effective in reducing the rhizome length and carbohydrate reserves.

In another experiment, Johnsongrass was successfully controlled in the same year that a crop of soybeans was harvested. Cultivation was needed in addition to dalapon preplow for Johnsongrass control plus either vernolate or trifluralin preplant incorporated for seedling Johnsongrass control.

Finally, the use of repeated applications of foliar herbicides such as MSMA and dalapon at 3 and 4 lb/A respectively were very effective in controlling Johnsongrass. Paraquat plus dalapon resulted in rapid kill, but Johnsongrass recovered. Soil sterilants such as Pramitol, Atlacide, and bromacil proved effective.

Table 1. The percent of Johnsongrass rhizomes living from the 8th and 9th tillage, Remington Farms, Kent County, 1968.

	% Johnsongrass Rhizomes Alive	
	(8th tillage) 8/21	(9th tillage) 9/17
Mowed check	85.2	83.5
Dalapon 7.4 lb/A 2 times	71.1	100.0
Disked surface	21.4	7.0
subsurface	17.0	8.3
Rototilled surface	13.9	2.4
subsurface	10.2	0
Spring tooth surface	16.9	8.3
subsurface	16.3	0

Table 2. Johnsongrass control in soybeans, Princess Anne, Maryland, Somerset County, 1968.

Treatment		% Johnsongrass[1] (10/1)			Bu/A Soybeans		
		Control Cult.	Not Cult.	Avg.	Cult.	Not Cult.	Avg.
1. Dalapon	5.0	93.3de[2]	50.3a	71.8A	32.8d	21.7a	27.3A
2. Dalapon	7.4	99.9f	53.6a	76.8A	31.7cd	26.1ab	28.9AB
3. Vernolate	3.0	96.4ef	84.0c	90.2B	31.2cd	27.0bc	29.1AB
4. Trifluralin	1.0	99.9f	95.8ef	97.9B	31.4cd	32.5d	32.0B
5. Dalapon + Vernolate	7.4 + 3.0	99.9f	76.1b	88.0B	33.1d	26.9bc	30.0AB
6. Dalapon + Vernolate	7.4 + 1.0	100.0f	91.8de	95.9B	31.5cd	32.4d	32.0B
Avg.		98.2x	75.2y		31.8x	27.7y	

[1]% control was determined by dividing the harvested Johnsongrass of treated plots with untreated, uncultivated adjacent plots and subtracting that from 100.

[2]Data followed by the same case letter are not significantly different at the .05 level.

Table 2. Johnsongrass control in soybeans, Princess Anne, Maryland, Somerset County, 1968.

Treatment	Rate/A	% Johnsongrass[1] (10/1)			Bu/A Soybeans		
		Control Cult.	Not Cult.	Avg.	Cult.	Not Cult.	Avg.
1. Dalapon	5.0	93.3de[2]	50.3a	71.8A	32.8d	21.7e	27.3A
2. Dalapon	7.4	99.9f	53.6a	76.8A	31.7cd	25.1ab	28.9AB
3. Vernolate	3.0	56.4ef	84.0c	90.2B	31.2cd	27.0bc	29.1AB
4. Trifluralin	1.0	99.9f	95.8ef	97.9B	31.4cd	32.5d	32.0B
5. Dalapon + Vernolate	7.4 + 3.0	99.9f	76.1b	88.0B	33.1d	26.9bc	30.0AB
6. Dalapon + Vernolate	7.4 + 1.0	100.0f	91.8de	95.9B	31.5cd	32.4d	32.0B
Avg.		98.2x	75.2y		31.8x	27.7y	

[1] % control was determined by dividing the harvested Johnsongrass of treated plots with untreated, uncultivated adjacent plots and subtracting that from 100.

[2] Data followed by the same case letter are not significantly different at the .05 level.

Table 3. Treatments for the control of Johnsongrass, Princess Anne, Maryland, Somerset County, 1968.

Treatment[1]	Rate	September 26	
		% Kill[2]	% Vigor Reduction[3]
1. Mowed check		0	100
2. MSMA	3 lb/A	98	17
3. Pramitol	1 lb/100 ft.^{2}	98	53
4. Pramitol	2 lb/100 ft.^{2}	100	0
5. Bromacil (Hyvar-X)	10 lb/A	96	37
6. Bromacil (Hyvar-X)	7 lb/A	89	67
7. Dalapon (Dowpon)	10 + 10 + surfactant (½%)	65	100
8. Dalapon (Dowpon)	7 + 7 + surfactant (½%)	77	87
9. Atlacide	1 lb/100 ft.^{2}	85	100
10. Atlacide	2 lb/100 ft.^{2}	99	17

[1] Treatments 3, 4, 9, 10 applied June 26, 1968 to 12" grass
Treatments 2, 5, 6, 7, 8 applied July 18, 1968 to 12" grass
Treatments 1, 2, 5, 6, 7, 8 mowed July 10, 1968
Treatments 7, 8 retreated July 26, 1968
Treatment 2 retreated August 23, 1968.

[2] 0 = no effect; 100 = 100% kill.

[3] 0 = no plant growth; 100 = the surviving plant(s) is completely vigorous.

Table 4. Experimental herbicides on Johnsongrass, Princess Anne, Maryland, Somerset County, 1968.

Treatment[1]	lb/A	September 26	
		% Kill	Vigor
1. Mowed Control		0	100
2. CP 41845 + surfactant	2	0	98
3. CP 41845 + surfactant	4	0	100
4. CP 41845 + surfactant	8	0	100
5. Daxtron	½	0	100
6. Daxtron + 2 gal/A 11E oil	½	0	100
7. 21E oil	20 gal/A	0	100
8. Dalapon + 1½ gal/A oil	4 (2X)	87	57
9. Paraquat	½ (2X)	10	95
10. Dalapon	4 (2X)	90	53
11. Dalapon + Paraquat (2X)	4 + ½	13	98

[1] Mowed - July 10
Sprayed - July 18 on 12 inch grass
Treatments 8, 9, 10, 11 resprayed July 25, 1968.

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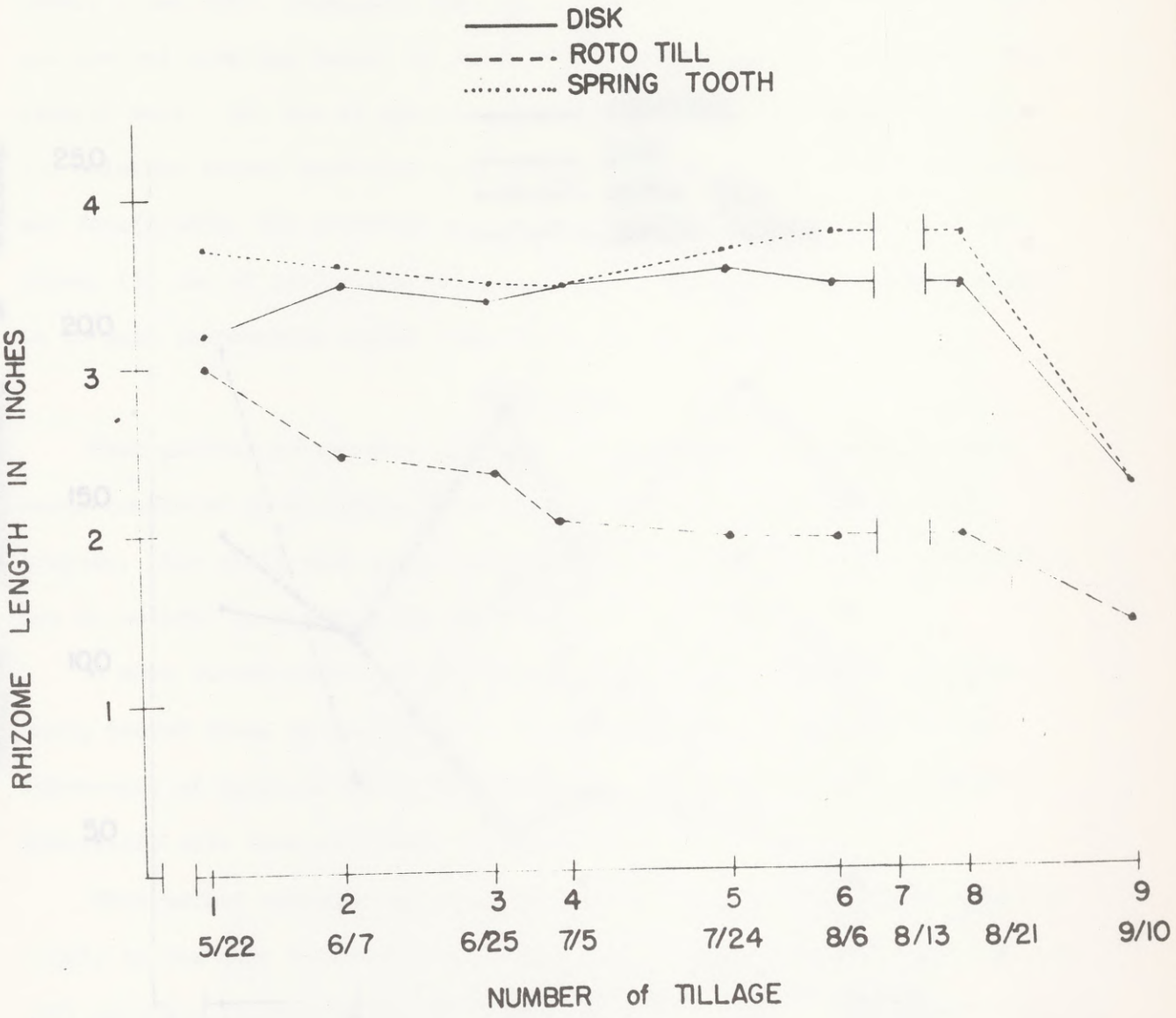
1. Mowed Control		0	100
2. CP 41845 + surfactant	2	0	98
3. CP 41845 + surfactant	4	0	100
4. CP 41845 + surfactant	8	0	100
5. Daxtron	¾	0	100
6. Daxtron + 2 gal\A IIE oil	¾	0	100
7. IIE oil	20 gal\A	0	100
8. Dalapon + 1¾ gal\A oil	4 (2%)	87	97
9. Paraquat	¾ (2%)	10	95
10. Dalapon	4 (2%)	90	93
11. Dalapon + Paraquat (2%)	4 + ¾	13	96

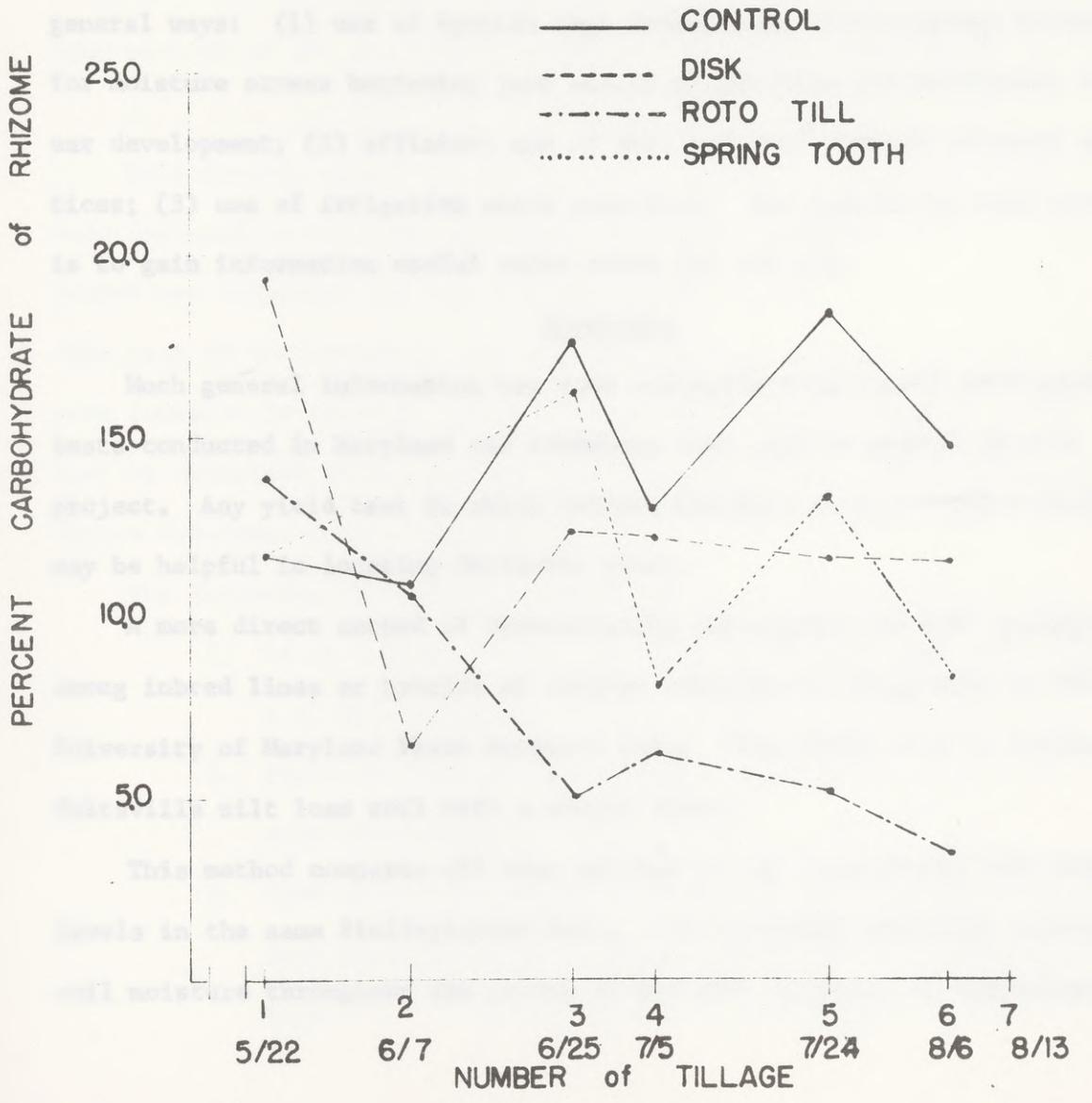
[1] Mowed - July 10
Sprayed - July 18 on 12 inch grass
Treatments 8, 9, 10, 11 resprayed July 25, 1968.

Figure 6. Johnsongrass rhizome length following repeated silo tillages by various equipment, Remington Farms, Chestertown, Maryland, 1968.



1
2
3
4
DISK
ROTO LAY
SPRING TOOTH

Figure 7. Carbohydrate reserves in Johnsongrass rhizomes following repeated silo tillage with different equipment, Remington Farms, Chestertown, Maryland, 1968.



Breeding and Selection for Improved Dent Corn

R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

Corn continues to be the major crop for grain or silage in Maryland. In 1967 it was harvested from 604,000 acres, or from about 40% of the state's total acreage harvested for all crops. Although yields per acre have been upward since 1967, inadequate mid-summer rainfall continues to be a frequent and serious limiting factor in production. Relief appears possible in three general ways: (1) use of hybrids that demonstrate above-average tolerance for moisture stress beginning just before pollination and continuing during ear development; (2) efficient use of soil moisture through cultural practices; (3) use of irrigation where practical. The purpose of this research is to gain information useful under items (1) and (3).

Procedure

Much general information has been collected from hybrid performance tests conducted in Maryland and elsewhere that will be useful in this project. Any yield test in which uniform moisture stress limited production may be helpful in locating desirable genes.

A more direct method of demonstrating comparative drought tolerance among inbred lines or hybrids of similar maturity is being used at the University of Maryland Plant Research Farm. This field test is located on Beltsville silt loam soil with a slight slope.

This method compares all test entries at two contrasting soil moisture levels in the same field-planted test. One treatment maintains near-optimum soil moisture throughout the growth of the corn by means of supplementary

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This method compares all test entries at two contrasting soil moisture levels in the same field-planted test. One treatment maintains near-optimum soil moisture throughout the growth of the corn by means of supplementary

irrigation by use of sprinkler hoses. The other treatment provides soil moisture stress near the beginning of the tasseling stage of growth. It depends upon the timely exclusion of rainfall from the soil by means of plastic sheeting carefully fitted around corn plants and between the corn rows. Time of plastic placement is highly important and depends on an accurate estimate of the time required for plant transpiration to reduce soil moisture to a stress level just prior to tasseling of the corn. At College Park with the tasseling period coming in late July or early August, a two to three-week interval has proved satisfactory. In case of unusually long periods of wet and cloudy weather this interval might prove too short.

Results

Satisfactory results were obtained in 1968. With ample rainfall up to July followed by moisture deficiency during ear formation of the corn, the season was favorable for the moisture-controlled test at College Park. In this test 16 open pedigree single crosses and their parental inbred lines were compared in separate tests - the single crosses in a plastic-restricted test as described above, and the inbreds in an adjacent open block where stress developed without plastic cover.

The following observations were made for the single cross test:

1. As an average for all 16 hybrids, irrigation resulted in a 40 bu/A increase.
2. Yield differences among hybrids at each moisture level were significant.
3. Five single crosses had yields well above average for both moisture levels. They will be compared again in 1969.

4. On the average, irrigated plants grew 8 inches taller, bore ears 6 inches higher, and had about half as many fired leaves as the drought-limited plants.

5. The following inbred lines showed good seed production under moisture stress: Oh 45, Oh 43, Oh 07, Pa 70, and H55.

Summary

Results obtained in 1968 are considered useful; however, several years of work of this nature will be necessary to accomplish the improvement that seems possible. As compared to checking for drought tolerance in an arid area where only irrigation is needed to create stress differences, similar work in a humid climate is more difficult in that rain water must be diverted from the test as required. This disadvantage may be offset by the opportunity for simultaneous selection for other characteristics of regional importance.

Small Grain Breeding and Evaluation

R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

The small grains, soft red winter wheat, winter barley, winter and spring oats, continue to be important Maryland farm crops as judged by the acreages harvested. Acreages reported for 1968 are as follows: wheat, 132,000; barley, 97,000; oats, 31,000. Use of higher rates of fertilizer, especially nitrogen on small grain calls for varieties that will make profitable response in yield and be able to stand erect for combine harvesting. The objective, therefore, is to find varieties of wheat, barley, and oats suitable for high fertility production in Maryland.

Procedure

1. Cooperative uniform nurseries for wheat, barley, and oats are planted annually on the University of Maryland Plant Research Farm. They are run in cooperation with USDA and State Experiment Stations concerned with small grain improvement in the eastern United States. At present there are two wheat nurseries, the Eastern and the Southern. Both nurseries are planted with a belt-type nursery seeder, with each entry planted in 4 replicate plots 2 rows x 16 ft. Plant records are taken for heading date, plant height, straw strength, powdery mildew, and other leaf diseases. Yield of threshed grain and bushel wt. are obtained. Grain samples are submitted each year for milling and baking tests at Wooster, Ohio. Results from all cooperating stations are sent to Beltsville to be tabulated and duplicated in mimeograph form for all cooperators.

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2. The more promising released varieties and experimental selections are included in field drill plot tests.

3. Experimental crosses are made from promising parental material.

4. All testing is done on land fertilized for high yields.

Results

Blueboy, a soft red winter wheat with short straw and good to excellent productivity recently released by the North Carolina Experiment Station, was included in the Southern Uniform Wheat Nursery prior to release. Also, in 1968 it was included in the 4-rep drill-plot test conducted on the Plant Research Farm near College Park. Yields for nine varieties of wheat are given below:

	Bu/A		Bu/A
Blueboy	58.6	Monon	45.5
Coker 57-6	54.3	Knox 62	44.9
Wakeland	52.2	Redcoat	43.3
Seneca	47.6	Benhur	42.7
Tayland	46.1		

LSD (5%) 6.9 bu.

Test planted 10/23/67 6 pks P/A

420 lbs/A 5-20-20 disked in

30 lbs/A N in am. nitrate. Topdressed 3/27/68

Studies With Double-Cropped Soybeans

J. A. Schillinger
Department of Agronomy

Purpose and Objectives

The increasing costs in agricultural production make it essential for farmers to get a maximum return from each acre. The use of double-cropping systems in Maryland has become very popular. Soybeans are the most frequently grown second crop in the double-cropping system. However, yields of soybeans in this system have been variable and very low during dry years.

The objectives of this study were (1) to determine the best soybean variety or maturity group for double-cropping, (2) to evaluate the effects of row width and seeding rate on soybean yields, and (3) to investigate the feasibility of double-cropping with soybeans in the Piedmont area of Maryland.

Procedure

Seven soybean varieties including Wayne, Cutler, Kent, Delmar, Dare, York, and D64-4731 were planted in two row widths -- 14" and 36", and three seeding rates -- 25, 50, and 75 pounds/acre. A randomized complete block design with three replications was used at three locations, Hurlock, McDaniel, and Snow Hill. At each location, the soybeans followed a barley crop which yielded 63, 50, and 55 bushels/acre at Hurlock, McDaniel, and Snow Hill, respectively.

Twenty-five soybean varieties and breeder lines which varied in maturity, morphological characteristics, seed size, and growth habit were planted on July 8 at Queenstown. A randomized complete block design with four replications was used. Each plot consisted of a single 20 ft. row planted in 30-inch row width.

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Twenty-five soybean varieties and breeder lines which varied in maturity, morphological characteristics, seed size, and growth habit were planted on July 8 at Queenstown. A randomized complete block design with four replications was used. Each plot consisted of a single 20 ft. row planted in 30-inch row width.

Seven varieties of soybeans were drilled at 90 pounds per acre after barley, at Taneytown and Clarksville on July 9, and 10, respectively. The varieties included Amsoy, Harosoy-63, Adelphia, Wayne, Clark-63, Kent, and Bethel. Four yield-strips (3' x 16') were taken at random from each variety.

Results

The yields of the six name varieties in the two row widths, averaged over all three seeding rates and 3 locations, are presented in Table 1. Soybeans in the 14-inch row width were distinctly higher in yield with an average difference of 6.0 bushels/acre for all varieties. The earlier-maturing varieties, Wayne, Cutler, Kent, and Delmar, had the greatest percentage increase in yields when row width was reduced to 14 inches. The effect of seeding rate was negligible with the average yields of all varieties being 31.4, 30.6, 29.9 bushels per acre at the 3 locations for the 25, 50, 75 pounds per acre seeding rates, respectively.

The agronomic performance of ten named varieties of soybeans planted on July 8 at Queenstown is given in Table 2. Superior yields were obtained in this study with varieties of maturity groups V and IV namely, York, Dare, Kent, and Cutler. Also, the later varieties, York, Dare, and Lee had their first pod higher off the ground (5 to 6 inches) as compared to Wayne, Calland, and Harosoy-63 varieties which had their first pods as low as two inches above the ground.

Despite the late dates of planting in the Piedmont studies, surprisingly high yields were found (Table 3). Wayne averaged 50.7 bushels per acre over both locations. Soybean varieties that matured about the same time as Wayne, namely Clark and Adelphia, also produced high yields of 45.4 and 40.2 bushels per acre. After yield strips were harvested at Taneytown, the farmer harvested the remaining four acres and averaged 42 bushels per acre.

Summary

Double-crop soybean studies in 1968 revealed a pronounced advantage to narrowing the row width with an average increase in yield of 6.0 bushels/acre. Several of the newly released soybean varieties showed promise in the double-cropping system, including York and Cutler. Yields of soybeans following barley in the Piedmont area of Maryland were outstanding and demand a closer evaluation.

Table 1. Narrow rows in soybeans planted after barley. Average of 3 locations - 1968.

Variety	Yield (Bu/A) 14"	Yield (Bu/A) 36"	Difference	% Inc. 14" vs 36"
Wayne	35.7	28.6	7.1	25
Cutler	35.0	28.7	6.3	22
Kent	34.4	28.4	6.0	21
Delmar	32.3	25.1	7.2	29
Dare	30.0	25.6	4.4	17
York	35.3	30.3	5.0	17
Average	33.8	27.8	6.0	

Table 2. Agronomic performance of 10 soybean varieties planted on July 8 at Queenstown, Md. 1968.

Variety	Yield (Bu/A)	Maturity Month/Day	HT (IN)	HT-1st Pod (IN)
Harosoy-63	27.6	10/10	19	2
Calland	33.7	10/17	24	3
Wayne	30.1	10/14	22	2
Adelphia	31.7	10/18	20	3
Cutler	36.3	10/21	22	3
Kent	35.5	10/24	24	3
Dare	35.4	10/28	28	5
Hill	29.7	10/28	26	4
York	38.9	10/30	26	5
Lee	31.6	11/2	29	6

Table 1. Narrow rows in soybeans planted after barley. Average of 3 locations - 1958.

Variety	Yield (Bu/A) 14"	Yield (Bu/A) 36"	Difference	% Inc. 14" vs 36"
Wayne	35.7	28.6	7.1	25
Cutler	35.0	28.7	6.3	22
Kent	34.4	28.4	6.0	21
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Harosoy-63	27.6	10/10	31	2
Calland	33.7	10/17	26	3
Wayne	30.1	10/14	32	2
Adelphia	31.7	10/18	30	3
Cutler	36.3	10/21	32	3
Kent	35.5	10/24	34	3
Dare	35.4	10/28	28	5
Hill	29.7	10/28	26	4
York	38.9	10/30	36	5
Lee	31.6	11/2	29	6

Table 3. Soybeans after barley in Piedmont Maryland.

Variety	Clarksville Yield	Taneytown Yield	Averages of Both Locations			
			Yield	Maturity	Hgt. (in.) Plant	Hgt. (in.) 1st Pod
Amsoy	44.4	40.0	42.2	10/18	27	3
Harosoy-63	37.2	30.4	33.8	10/19	20	2
Wayne	45.5	55.9	50.7	10/20	32	4
Clark	--	45.4	45.4	10/26	28	6
Adelphia	30.8	50.4	40.2	10/28	26	5
Kent	28.4	44.6	36.5	10/29	30	6
Bethel	21.1	36.0	28.6	11/4	38	7
Dare*	--					

*Frost killed the Dare variety on October 25.

Note: The soybeans were planted on July 10 after barley. The yield of barley at Clarksville was 45 bu. per acre and at Taneytown 50 bu. per acre.

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Harosoy-63	37.2	30.4	33.8	10\15	20	2
Wayne	45.5	55.5	50.7	10\20	32	4
Clark	--	45.4	45.4	10\26	28	6
Adelphia	30.8	50.4	40.2	10\28	26	5
Kent	28.4	44.6	36.5	10\23	30	6
Bethel	21.1	36.0	28.6	11\4	38	7
Dare*	--					

*Frost killed the Dare variety on October 23.

Note: The soybeans were planted on July 10 after barley. The yield of barley at Clarksville was 45 bu. per acre and at Taneytown 30 bu. per acre.

Breeding For Improved Red Clover Varieties

J. A. Schillinger
Department of Agronomy

Purpose and Objectives

Red clover has proven itself a valuable forage species for Maryland. Its most serious deficiency is lack of persistence. Selection for improved persistence in red clover is complicated by the many factors involved. Lack of persistence has been attributed to physiological (internal breakdown), pathological (Southern anthracnose, crown rots, virus infections), and entomological factors (aphids, leafhopper, root borers). The information presented in this report represents the culmination of twelve years of selection for persistent red clover. The objective of this study is to evaluate the agronomic performance of newly synthesized red clover synthetics that are composed of clones selected for improved persistence.

Procedure

Seven red clover synthetics were made during 1967-68 in the greenhouse and field screenhouse. The synthetics were composed as follows:

Maryland #1 - Intercross progeny of clones that survived three years in field. Original clones were from Kentucky Syn A-2 and Chesapeake.

Maryland #2 - Clones surviving in vigorous state after two years. Origination: farmer selections collected in 1956.

Maryland #3 - Similar to #2 except superior polycross progeny were selected to make up synthetic.

MD P I - Surviving clones after 2 years originating from clones obtained from USDA Pathology Section at Penn State.

MD P II - Similar to MD P I but different selections.

MD P III - Similar to MD P I but different selections.

MD P IV - Similar to MD P I but different selections.

Seeds from each of these synthetics were harvested, threshed by hand, cleaned, scarified, and seeded in a yield trial at Clarksville in May 1968. A randomized complete block design was used which included three replications. Plot size was 5 x 10 feet. Five red clover varieties were also seeded in the study.

Results

The seedling year yields of the seven new Maryland red clover synthetics and the five red clover varieties are given in Table 1. The yields were comparatively small due to the droughty conditions in July and August. However, the performance of Maryland #1 and #2 and MD P I were encouraging.

Summary

Seven new red clover synthetics were made during 1967-68 and were seeded in a forage evaluation study at Clarksville. Preliminary data from several of these synthetics have been encouraging, as they have outyielded Chesapeake.

Table 1. Yields of the seedling year harvest of Red Clover, Clarksville, 1968.

Entry	Yield	
Illinois #2	1.25	Tons/Acre
Maryland #1	1.21	"
Maryland #2	1.07	"
Md. P I	1.06	"
Kenland	1.04	"
Md. P IV	0.94	"
Ky Syn A-2	0.93	"
Md. P III	0.89	"
Chesapeake	0.85	"
Md. #3	0.85	"
Md. P II	0.80	"
Pennscott	0.65	"

Alfalfa Weevil Control Through The Use Of Resistant Varieties And Harvest Management

J. A. Schillinger, D. H. Barnes, C. H. Hanson, and R. H. Ratcliffe
Department of Agronomy and Agricultural Research Service, USDA

Purpose and Objectives

The alfalfa weevil is considered the most important forage pest in the United States. Its impact on alfalfa in the eastern United States has been realized in drastically reduced acreages. After 15 years of phenotypic selection for resistance to the alfalfa weevil, a new weevil resistant variety, Team, was developed by the USDA and Agricultural experiment stations of Maryland and North Carolina. These studies were designed to evaluate the agronomic performance of this new variety under various management treatments and to determine how much protection its resistance gives to alfalfa against the weevil.

Procedure

Four harvest and insecticidal spray managements were imposed on five alfalfa varieties including Team (MSHp6), Saranac, Iroquois, Cherokee, and Vernal. The treatments were as follows:

Management A - Alfalfa harvested when 50% terminals were damaged by weevil and stubble not sprayed.

Management B - Same as A except, stubble sprayed with Methoxychlor (1½ lbs/A actual).

Management C - Spray alfalfa with Methoxychlor at above rate with 50% terminals show damage and harvest at 1/10 bloom and stubble not sprayed.

Management D - Same as C, except spray stubble with Methoxychlor.

The study was established in April 1967. The soil pH was adjusted to 6.8, and 20-80-80 (lbs. per acre of N, P_2O_5 and K_2O, respectively) was applied before seeding. Alfalfa was seeded at the rate of 16 lbs. per acre. In the fall 0-120-240 + Boron was applied to the alfalfa.

The experimental design was split-plot with the four management practices as whole plots and five varieties as subplots. Six replications were used with plot size being 5 x 20 ft.

Data recorded included dry matter production, alfalfa weevil larval counts, stand counts, and anthracnose and Stemphylium leaf spot ratings.

Results

Table 1 contains the yield data of Team in comparison with four widely grown varieties. The yields for the two early harvest managements are combined as are the yields for the 1/10 bloom harvests. Team produced the highest tons/acre of dry matter under both harvest managements.

Team's ability to lessen the detrimental effects of the alfalfa weevil are indicated in the data of Table 2. Both the numbers and size of weevil larvae were lower on Team than other varieties. Even though absolute resistance to the weevil is not realized in Team, the level of weevil resistance together with an early cutting management should relieve the necessity of insecticidal sprays in most years.

Evaluations of Stemphylium leaf spot and anthracnose infections on Team and four other alfalfa varieties at Clarksville are presented in Table 3. Team was similar to Cherokee and Saranac, and was superior to Iroquois and Vernal in its Stemphylium scores. Its resistance to anthracnose was superior to Saranac and Iroquois. Reductions in stands from July 1967 to April 1968 were 12.6, 16.6, 18.6, 28.4, and 39.0% for Team, Cherokee, Saranac, Iroquois, and Vernal, respectively.

The study was established in April 1957. The soil pH was adjusted to 6.8, and 20-80-80 (lbs. per acre of N, P_2O_5 and K_2O, respectively) was applied before seeding. Alfalfa was seeded at the rate of 16 lbs. per acre. In the fall 0-120-240 + Boron was applied to the alfalfa.

The experimental design was split-plot with the four management practices as whole plots and five varieties as subplots. Six replications were used with plot size being 5 x 20 ft.

Data recorded included dry matter production, alfalfa weevil larval counts, stand counts, and anthracnose and Stemphylium leaf spot ratings.

Results

Table 1 contains the yield data of Team in comparison with four widely grown varieties. The yields for the two early harvest managements are combined as are the yields for the 1/10 bloom harvests. Team produced the highest tons/acre of dry matter under both harvest managements.

Team's ability to lessen the detrimental effects of the alfalfa weevil are indicated in the data of Table 2. Both the numbers and size of weevil larvae were lower on Team than other varieties. Even though absolute resistance to the weevil is not realized in Team, the level of weevil resistance together with an early cutting management should relieve the necessity of insecticidal sprays in most years.

Evaluations of Stemphylium leaf spot and anthracnose infections on Team and four other alfalfa varieties at Clarksville are presented in Table 3. Team was similar to Cherokee and Saranac, and was superior to Iroquois and Vernal in its Stemphylium scores. Its resistance to anthracnose was superior to Saranac and Iroquois. Reductions in stands from July 1957 to April 1958 were 12.6, 15.6, 18.6, 28.4, and 39.0% for Team, Cherokee, Saranac, Iroquois, and Vernal, respectively.

Summary

A new alfalfa weevil resistant variety of alfalfa, Team, was evaluated for its agronomic performance under four harvest-insecticidal managements. The yielding potential of Team was evident in this study with a yield of 6.22 tons of dry matter per acre harvested under the 1/10 bloom cutting management. The level of resistance to the alfalfa weevil, while low, should give Team an advantage over existing varieties. An additional bonus of Team is its higher resistance to anthracnose and Stemphylium leaf spot.

Team was cooperatively released by the USDA Crops and Entomology Research Divisions and the Agricultural Experiment Stations of Maryland, North Carolina and Virginia in January 1969, and seed will be available for farmers in the Spring of 1970.

Table 1. First harvest year (1968) yield data on 1967 alfalfa weevil management trial, Clarksville, Md. Total yields of 4 cuttings and average weed infestation of 5 replications.

Variety	Early Harvest[1]		Normal Harvest[2]	
	Total Yield	% Weeds[3]	Total Yield	% Weeds[3]
Team	5.87	6.5	6.22	36
Cherokee	5.83	5.5	5.98	36
Iroquois	5.44	17.0	5.75	56
Saranac	5.48	6.0	5.95	45
Vernal	5.25	13.0	5.52	68
LSD (.05)	.20		.38	

[1]At time when 50% terminals show weevil damage.

[2]1/10 bloom.

[3]On August 1, 1968.

Plot size: 5' x 20'.

Table 2. Alfalfa weevil data from a field evaluation of Team and check varieties, Clarksville, Md.

Entry	Damaged terminals[1]	Larvae/kg green wt.[2]		Larvae/kg green wt.[3]	
	5-6-68 (%)	5-6-68 (no.)	5-6-68 (dg)	5-22-68 (no.)	5-22-68 (dg)
MSHp6 (Team)	47	199	9.9	102	8.1
Cherokee	54	258	13.4	200	15.1
Iroquois	52	253	13.1	186	17.7
Saranac	55	304	14.6	184	13.0
Vernal	53	284	15.6	190	15.3
LSD (.05)	5	23	3.3	NS	NS

[1]Weevil infestation was relatively light throughout most of the plot area. Data represent larval populations prior to insecticide treatment.

[2]Data represent mean of 20 replications, each replication consists of one 5' x 20' broadcast plot per entry.

[3]Data represent mean of 4 replications.

Table 1. Plant harvest year (1966) yield data on 1967 alfalfa weevil management trial, Clarksville, Md. Total yields of 4 cuttings and average weed infestation of 3 replications.

Variety	Early Harvest[1]		Normal Harvest[2]	
	Total Yield	% Weeds[3]	Total Yield	% Weeds[3]
Team	5.07	6.3	6.22	36
Cherokee	5.83	5.3	5.96	26
Iroquois	5.44	17.0	5.75	26
Saranac	5.48	6.0	5.95	45
Vernal	5.25	13.0	5.52	66
LSD (.05)	.20		.28	

[1]At time when 50% terminals show weevil damage.

[2]1/10 bloom.

[3]On August 1, 1966.

Plot size: 5' x 20'.

Table 2. Alfalfa weevil data from a field evaluation of Team and check varieties, Clarksville, Md.

Entry	Damaged terminals[1]		Larvae/100 sweeps[2]		Larvae/10 sweeps[3]	
	5-6-66 (%)	5-6-66 (no.)	5-23-66 (dg)	5-23-66 (no.)	5-22-66 (dg)	5-22-66 (no.)
1958Pp6 (Team)	47	159	9.9	102	0.1	1
Cherokee	54	258	13.4	200	15.1	2
Iroquois	52	253	13.1	106	17.7	3
Saranac	55	304	14.5	164	13.0	2
Vernal	53	284	15.6	190	15.3	3
LSD (.05)	5	23	3.3	NS	NS	

[1]Weevil infestation was relatively light throughout most of the plot area. Data represent larval populations prior to insecticide treatment.

[2]Data represent mean of 20 replications, each replication consists of one 3' x 20' broadcast plot per entry.

[3]Data represent mean of 4 replications.

Table 3. Field disease evaluations on broadcast plots of MSHp6 and check varieties, Clarkesville, Md.

Entry	Stemphylium		Anthracnose	
	9-18-67[1]	11-4-68[1]	9-18-67[1]	8-1-68[2]
MSHp6 (Team)	2.6	2.0	1.3	4.3
Cherokee	2.3	2.3	1.4	4.6
Iroquois	2.7	2.8	2.1	7.4
Saranac	2.5	1.9	2.2	7.4
Vernal	3.8	3.4	1.6	5.6
LSD (.05)	.24	.60	.61	1.69

[1]Disease ratings scored 1 to 4: 1 = none, 2 = slight, 3 = moderate and 4 = severe damage (19 replications).

[2]Disease ratings scored 1 to 9: 1 = none and 9 = severe damage (20 replications).

Soybean Varietal Improvement for Fertility Response

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Purpose and Objectives

Perhaps the most unexplained phenomenon related to soybean production is its unpredictable response to added fertilizer. Histories of farms producing consistently high soybean yields reveal a program of high fertility practices maintained over a number of years. Yet, in many studies of direct applications of fertilizer to soybeans, little or no increase in yield is obtained.

The objectives of these studies were: (1) to evaluate different varieties of soybeans for their fertility responsiveness, (2) to evaluate plant introductions for their responsiveness to high fertility, and (3) to study the inheritance of response to high fertility.

Procedure

Greenhouse

Four varieties of soybeans; Clark, Kent, Delmar and Dare were grown in nutrient cultures which varied only by phosphorus level. Three levels of H_2PO_4 (0.01, 0.10, and 1.00 m.e./L) were used and were referred to as low P, medium P, and high P. Three replications of each treatment were evaluated. Growth rates and yield components (pods, seeds per pod, and seed size) were studied for each variety under each of the phosphorus levels.

Field

Four fertility blocks were established in the fall of 1967 at the Wye Institute. These blocks were as follows:

Block	1(NF)	No added fertility.
Block	2(K)	600 pounds/acre K_2O added.
Block	3(PK)	Same as #2 plus 400 pounds/acre P_2O_5.
Block	4(P)	400 pounds/acre P_2O_5 added.

The soil analysis of these blocks before fertilizers were added, and in the spring and Fall of 1968, after fertilizers were added is presented in Table 1.

Within each fertility block, 800 soybean genotypes were planted in two replications. A plot consisted of a three-foot row planted with 20 seeds. Soybean maturity groups II, III, IV, and V were represented in this study. Response to fertility was based on increases in yield of genotypes in Blocks 2, 3, and 4 over its yield in Block 1.

Results

The differential performances of 4 varieties under 3 levels of P fertility in the greenhouse are indicated in Table 2. Under low P, Delmar had the ability to produce more pods and higher total seed weights than the other varieties. At the high P level, Delmar and Dare produced similar pod numbers per plant, but Delmar produced a greater seed weight.

Also, evidenced in this study was the difference in axillary shoot development under the three phosphorus levels (Table 3). Delmar and Dare produced more shoots under low P conditions, and Delmar produced more under the high P conditions.

The data from the field study have only been partially summarized. However, data from five genotypes derived from the Dare variety (Dare 9R, Dare 82NR, Dare 84NR, Dare 62R, and Dare 54R), the original Dare variety, and Delmar are presented in Table 4. Delmar again produced its largest yield in the high phosphorus block as it did in the greenhouse. The five Dare selections responded differently to the fertility treatments. Dare 9R gave its highest yields under the high potassium treatments, whereas Dare 84NR produced its highest yields in the high phosphorus treatments. The unselected Dare gave little response to either fertility treatment.

Responding genotypes have been selected out of each soybean maturity group and will be retested next year in these same blocks with larger plots and more replications. Crosses have been made bewteen responders to K and responders to P, and the F_2 populations of these will be studied under high fertility conditions in the field.

Summary

Preliminary data collected to-date indicate differences in response to high fertility exists in soybean genotypes. After verifying these findings, progress toward the development of soybeans that will more efficiently utilize high fertility, should be forthcoming.

Responding genotypes have been selected out of each soybean maturity group and will be retested next year in these same blocks with larger plots and more replications. Crosses have been made between responders to K and responders to P, and the F_2 populations of these will be studied under high fertility conditions in the field.

Summary

Preliminary data collected to-date indicate differences in response to high fertility exists in soybean genotypes. After verifying these findings, progress toward the development of soybeans that will more efficiently utilize high fertility, should be forthcoming.

Table 1. Soil analysis of fertility blocks established 1967 at Wye Institute to evaluate soybean genotypes.

Block	Date	pH	Mg	P_2O_5	K_2O
1(NF)	10/67	6.3	224+VH	110M	105M
	4/68	6.4	224+VH	130M	120M
	10/68	6.3	224+VH	145M	102M
2(K)	10/67	6.3	224+VH	110M	95M
	4/68	6.2	224+VH	120M	189H
	10/68	6.3	224+VH	135M	201H
3(PK)	10/67	6.4	224+VH	96M	101M
	4/68	6.3	224+VH	175H	273H
	10/68	6.3	224+VH	195H	240H
4(P)	10/67	6.3	224+VH	102M	108M
	4/68	6.3	224+VH	190H	105M
	10/68	6.3	224+VH	195H	66L

Table 2. Responses of 4 soybean varieties to 3 levels of phosphorus in greenhouse nutrient culture studies.

Phosphorus Level	Number of Pods/plant				Seed Weight/plant			
	Clark	Kent	Delmar	Dare	Clark	Kent	Delmar	Dare
Low P	68	178	192	56	23	56	90	17
Med. P	216	213	225	290	114	82	95	102
High P	238	275	365	371	93	114	162	118

Table 1. Soil analysis of fertility blocks established 1957 at Wye Institute to evaluate soybean genotypes.

Block	Date	pH	Mg	P_2O_5	K_2O
1(MK)	10/67	6.3	224+VH	110M	103M
	4/68	6.4	224+VH	130M	120M
	10/68	6.3	224+VH	145M	102M
2(K)	10/67	6.3	224+VH	110M	95M
	4/68	6.2	224+VH	120M	139H
	10/68	6.3	224+VH	135M	201H
3(PK)	10/67	6.4	224+VH	95M	101M
	4/68	6.3	224+VH	175H	272H
	10/68	6.3	224+VH	195H	240H
4(P)	10/67	6.3	224+VH	102M	108M
	4/68	6.3	224+VH	190H	102M
	10/68	6.3	224+VH	195H	95L

Table 2. Responses of 4 soybean varieties to 3 levels of phosphorus in greenhouse nutrient culture studies.

Phosphorus Level	Number of Pods/plant				Seed Weight/plant			
	Clark	Kent	Delmar	Dare	Clark	Kent	Delmar	Dare
Low P	68	178	102	56	23	56	90	17
Med. P	216	213	225	290	114	82	95	102
High P	238	275	365	371	93	114	162	118

Table 3. Axillary shoot development one month after planting of 4 soybean varieties under 3 phosphorus levels.

Variety	Average Number[1] of Axillary Shoots Phosphorus Levels		
	High	Med.	Low
Kent	13.5	16.0	10.5
Clark	14.5	18.0	11.5
Delmar	16.5	18.5	14.0
Dare	15.0	18.0	13.5

[1]Average of 3 replications.

Table 4. Yield (grams of seed/3 linear feet) of 5 Dare selections and Delmar soybeans under 4 fertility levels. Queenstown, Md. 1968.

Selection	Fertility Level						
	Block 1 (NF)	Block 2(K)		Block 4(P)		Block 3(PK)	
	Yield	Yield	Response[1]	Yield	Response	Yield	Response
Delmar	448	361	-87	575	+127	411	-37
Dare 9R	357	404	+47	320	- 37	407	+50
Dare 82NR	495	404	-91	524	+ 29	401	-94
Dare 84NR	438	381	-57	585	+147	448	+10
Dare 62R	434	434	0	477	+ 43	391	-43
Dare 54R	420	361	-59	479	+ 59	366	-54
Dare	376	344	-32	409	+ 33	364	-12
			-40		+ 57		-26

[1]Response is equal to Block 2 - Block 1, Block 4 - Block 1, Block 3 - Block 1.

Table 3. Axillary shoot development one month after planting of 4 soybean varieties under 3 phosphorus levels.

Variety	Average Number[1] of Axillary Shoots per Phosphorus Levels		
	High	Med.	Low
Kent	13.5	16.0	10.5
Clark	14.5	18.0	11.5
Delmar	16.5	18.5	14.0
Dare	15.0	18.0	13.5

[1]Average of 3 replications.

Table 4. Yield (grams of seed/3 linear feet) of 5 Dare selections and Delmar soybeans under 4 fertility levels. Queenstown, Md. 1966.

Selection	Fertility Level							
	Block 1 (NP)		Block 2(K)		Block 4(P)		Block 3(NK)	
	Yield	Yield	Response	Yield	Response	Yield	Response	
Delmar	448	351	-87	575	+127	411	-37	
Dare SR	357	404	+47	320	- 37	407	+50	
Dare 82NR	495	404	-91	524	+ 29	401	-94	
Dare 84NR	438	381	-57	585	+147	448	+10	
Dare 62R	434	434	0	477	+ 43	391	-43	
Dare 54R	420	361	-59	479	+ 59	365	-54	
Dare	376	344	-32	406	+ 59	364	-12	
			-40		+ 57		-26	

[1]Response is equal to Block 2 - Block 1, Block 4 - Block 1, Block 3 - Block 1.

Feeding Value and Agronomic Performance of Team, WL303, and Williamsburg Alfalfa Varieties

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Purpose and Objectives

The evaluation of the feeding value of new varieties of alfalfa prior to their release has not been common. With the development of varieties with more insect and disease resistance, data on animal performance of these new varieties may be critical. The purpose of this study was to determine the feeding value of three alfalfa varieties, as indicated by intake and in vivo digestibility, and to evaluate the agronomic performance of these varieties under large field plot conditions.

Procedure

A randomized block design with five replications was used. The study area was seeded on April 17, 1968 at the rate of 12 pounds per acre. The soil pH was adjusted to 6.9 and 20-80-80 (lbs. per acre of N, P_2O_5 and K_2O, respectively) was applied prior to seeding. Eptam, applied preplant, was incorporated at four pounds of actual material per acre. The plot size was 120' x 120' or approximately 1/3 acre per plot.

The alfalfa was harvested with conventional farm equipment, and the baled hay from each plot was weighed before it was stored. Feeding trials were conducted on hay taken from two harvests. Nine Holstein heifers were used to evaluate feeding quality. Data were collected on intake and in vivo digestibility.

Results

Hay yields for two seedling year harvests are presented in Table 1. The Team variety produced higher yields in both harvests than WL303 or Williamsburg, even though the differences were not significant at the 5% level of probability.

The feeding value of Team, Williamsburg, and WL303 was measured from 2 cuttings taken from seedling year stands. Results of a preliminary feeding study are shown in Table 2. Intake and digestibility values for dry matter of all three varieties were similar with Team having a slight advantage.

Summary

Preliminary data from seedling year stands indicate that Team will not have any detrimental effect on animal performance. Also, forage yields indicate Team will produce well under Maryland conditions in the seedling year.

Table 1. Yield data in year of establishment on 1968 dairy animal and agronomic performance trial of three alfalfa varieties, Clarksville, Maryland.

Entry	Yield - tons dry matter/acre		
	7-11-68	9-1-68	Total
Team	1.80	.59	2.39
Williamsburg	1.57	.53	2.10
WL303	1.58	.48	2.06
LSD (.05)	ns	ns	ns

Seeding date: 4-17-68

Plot size: 120' x 120'

Design: Randomized block with 5 replications.

Table 2. Preliminary summary of relative intake and digestibility of seedling year hay harvested 7-11-68 from MSHp7, Williamsburg, and WL303 alfalfa.

Source of hay	Steer (No.)	Dry matter intake (% of body weight)[1]	Dry matter digestibility (%)[1]
Team	479	2.54	59.5
	483	2.78	58.7
	491	2.68	50.3
Average		2.67	56.2
Williamsburg	482	2.56	57.9
	490	2.58	51.4
	492	2.44	52.8
Average		2.53	54.0
WL303	477	2.65	58.8
	481	2.46	55.7
	486	2.34	54.6
Average		2.48	56.4

[1]Analytical dry matter has not been determined as yet and the above calculations are based on the assumed dry matter content of 90% for the hays.

Table 2. Preliminary summary of relative intake and digestibility of weanling year hay harvested 7-11-68 from HSHp, Williamsburg, and WL303 alfalfa.

Source of hay	Steer (No.)	Dry matter intake (% of body weight)[1]	Dry matter digestibility (%)[1]
Team	479	2.54	59.5
	483	2.78	58.7
	491	2.68	50.3
Average		2.67	56.2
Williamsburg	482	2.56	57.9
	490	2.58	51.4
	492	2.44	52.8
Average		2.53	54.0
WL303	477	2.65	58.8
	481	2.46	55.7
	486	2.34	54.6
Average		2.48	56.4

[1] Analytical dry matter has not been determined as yet and the above calculations are based on the assumed dry matter content of 90% for the hays.

Breeding and Evaluation of Soybean Genotypes

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Purpose and Objectives

To obtain soybean varieties, adapted for the Mid-Atlantic states, which are superior to varieties currently grown in this area.

Procedure

By making the appropriate crosses, populations containing germ plasm for high yield and high protein are developed and maintained.

During 1968 soybean genotypes developed at Beltsville and by other plant breeders were evaluated. Uniform Group tests IV, IVS, V, and VI and Uniform Preliminary Group tests IV, IVS, and V were grown at Linkwood, Maryland. Uniform Group tests IV, IVS, V, VI, and Uniform Preliminary Group tests IV and IVS were grown at the Wye Institute. A Mid-Atlantic test consisting of 14 Maryland and 12 Delaware lines was also grown at the above locations.

Results

The aforementioned tests were grown in order that the agronomic characteristics of these genotypes could be evaluated in Maryland. Primary emphasis was placed on yield, maturity date, lodging, seed size, and percentage of protein and oil. Six genotypes developed at Beltsville are being considered for the possible release of at least one during the next two years. Data on these genotypes are found in Tables 1, 2, and 3.

The data in Table 1 show that Md63-3303-3 yields as high as Cutler -- a newly released variety. Md63-3303-3 is a few days later in maturity, has better seed quality, and lodges less than does Cutler. This line is

6-7 inches shorter than Cutler and may be adapted to narrow rows, i.e., Linkwood 38", Wye Institute 30", and Clarksville, 30". This line has been advanced to the Uniform Group IV test for 1969 evaluation.

Table 2 contains the data of 2 lines which seem to be well adapted to the sandy soils and the environmental conditions of the Mid-Atlantic states. Md62-2313 is four days later than Cutler and Clark and has very little shattering. This line is comparable in yield to Cutler and Clark and has been advanced to the Uniform Group IVS test for 1969. This line has also yielded well at Warsaw, Va.

Md62-3514 has consistently been as high or higher in yield as Cutler. It is one week later and holds its seed better than does Cutler. This line seems to be well adapted to the soybean growing areas of the Eastern Shore.

Our lines of Maturity Group V are listed in Table 3. Md64-338 which yielded so well at Linkwood, Md. and Warsaw, Va. in 1968, was selected from a 1967 yield test in which it ranked 12 of 14. Md64-404 and Md64-429 ranked 1 and 2 in the same test. The seed of these two lines was lost in the mail so they were not yield-tested in 1968.

Md64-338 outyielded York by 4 bushels at Warsaw, Va., the location at which York was developed. This line is higher than York and equal to Dare in protein and oil. It is Hill maturity and matures 5-6 days earlier than York and Dare.

Studies were also made of the yields of blends of different soybean genotypes. One of our priority studies is that involving soybean genotypes with high protein seed. Some of the data from this study is summarized in Table 4.

Ten of our high protein lines are compared to check varieties in Table 4. The protein percentage of these lines is much higher than Cutler or Delmar. The yield of a few of the lines is equivalent to Delmar and only slightly less than Cutler. Although there is an inverse relationship between protein and oil, the oil content of these high protein lines is not as low as expected.

Many plant rows were also evaluated in 1968 and the best appearing rows and plants within rows were selected for increase and/or testing next year.

Summary

The agronomic data for all genotypes grown in 1968 have been compiled, and selection of superior genotypes will be made based on their overall performance and potential as possible varieties in the Mid-Atlantic states.

Ten of our high protein lines are compared to check varieties in Table 4. The protein percentage of these lines is much higher than Cutler or Delmar. The yield of a few of the lines is equivalent to Delmar and only slightly less than Cutler. Although there is an inverse relationship between protein and oil, the oil content of these high protein lines is not as low as expected.

Many plant rows were also evaluated in 1960 and the best appearing rows and plants within rows were selected for increase and/or testing next year.

Summary

The agronomic data for all genotypes grown in 1960 have been compiled, and selection of superior genotypes will be made based on their overall performance and potential as possible varieties in the Mid-Atlantic states.

Table 1. Maryland line of maturity group IV being considered for future release.

	Linkwood 1966	Linkwood 1967	Linkwood 1968	Wye Inst. 1968	Clarksville 1968	$\bar{X}$ for 1968	% Protein	% Oil
Md 63-3303-3	37.0*	38.2	42.6	43.3	60.2	48.7	40.6	23.5
Clark	31.6	25.3	41.7	41.3	54.8	45.9	41.1	22.6
Cutler	--	40.0	47.6	41.3	56.5	48.5	42.2	22.0

*Yields in bu./Acre.

Yields in bu./acre.

Cooler	Crank	M2 52-3303-3	Redwood 1959	Redwood 1957	Redwood 1960	Wye Inst. 1960	Charlesville 1960	% for Tests	% Out
--	31.6	37.0*	40.5	39.2	40.5	50.2	40.7	40.6	25.5
40.0	35.5	41.7	41.3	41.3	54.0	52.2	45.2	41.4	22.5
47.5	41.3	49.5	42.2	42.5	50.2	49.5	46.2	42.2	12.5

Test = 1 Harvest line of matrix (2 rows) in Dr. W. Cross reserve for future release.

Table 2. Two Maryland lines of maturity group IVS being considered for future release.

	Linkwood* 1966	Linkwood 1967	Wye Institute 1967	Linkwood 1968	Wye Institute 1968	Clarksville 1968	(1966, 67, 68 X	% Protein	% Oil
Md 62-2313	35.2	42.4	40.1	42.7	39.0	50.9	41.8	40.3	23.2
Md 62-3514	34.8	43.2	44.7	44.4	44.9	51.1	43.8	40.1	22.6
Clark	28.0	39.8	43.3	41.7	41.3	54.8	41.5	40.7	22.7
Cutler	25.9	39.0	41.5	47.6	41.3	56.5	42.0	41.5	22.2

*Yields in bu./acre.

Missing or partial.

Table 3. Maryland lines of maturity group V considered for future release.

	Linkwood[1] 1967	Linkwood 1968	Warsaw Va. 1968	$\bar{X}$
York	36.5	--	38.0	--
Hill	34.9	35.1	38.0	36.0
Dare	36.3	36.8	38.0	37.0
Md 64-338	32.0	40.1	41.9	38.0
Md 64-404*	42.4	--	--	
Md 64-429*	43.1	--	--	
$\bar{X}$	37.5	37.3	39.0	

*Lost in mail - now being increased for further testing.

[1]Yields in bu./acre.

Table 3. Maryland lines of maturity group V considered for future release.

	Linwood[1] 1967	Linwood 1968	Warsaw Va. 1968	$\bar{X}$
York	36.5	--	38.0	--
Hill	34.9	35.1	38.0	36.0
Dare	36.3	36.8	38.0	37.0
Md 64-338	32.0	40.1	41.5	36.0
Md 64-404*	42.4	--	--	
Md 64-429*	43.1	--	--	
$\bar{X}$	37.5	37.3	39.0	

*Lost in mail - now being increased for further testing.

[1]Yields in bu./acre.

Table 4. Maryland high protein lines.

Maturity Group IV	Linkwood 1967			Linkwood 1968			Queenstown 1968			$\bar{X}$		
	Protein %	Oil %	Yield*	Protein %	Oil %	Yield	Protein %	Oil %	Yield	Protein %	Oil %	Yield
Cutler	42.2	21.6	33.6	41.3	23.1	47.2	42.8	22.2	40.2	42.1	22.3	40.3
Md 65-1602	47.4	19.8	35.8	45.4	21.4	37.0	47.4	21.4	35.4	46.7	20.9	36.1
Md 65-3807	46.5	20.3	32.0	44.9	21.6	39.8	46.5	21.5	36.2	46.0	21.1	36.0
Md 65-2611	46.2	19.3	36.0	42.5	20.7	29.3	48.3	18.6	19.9	45.7	19.5	28.4
Md 65-1515	46.9	19.1	35.7	44.2	21.2	38.7	45.9	20.1	37.4	45.7	20.1	37.3
Md. 65-3515	46.1	19.7	36.9	44.2	21.1	36.8	46.5	22.3	28.8	45.6	21.7	34.2
Maturity Group IVS												
Delmar	41.8	21.7	34.2	38.8	23.1	37.8	43.1	22.0	31.8	41.2	22.3	36.7
Md 65-3802	47.9	18.1	33.6	46.2	19.5	32.2	45.5	20.9	21.6	46.5	19.5	29.1
Md 65-3714	47.3	18.9	34.6	45.1	20.8	33.3	45.1	20.5	27.2	45.8	20.1	31.7
Md 65-2403	45.8	18.7	41.5	44.5	21.0	34.4	45.0	20.4	32.6	45.1	20.0	36.2
Md. 65-3412	45.0	19.5	37.8	44.9	20.9	38.7	43.2	19.9	26.3	44.4	20.1	34.3
Md 65-1702	45.8	20.0	42.2	43.9	21.8	33.8	43.2	21.7	31.0	44.3	21.2	35.7

*Yield in bu./acre.

*Data Not Plotted

| | | |

The Development of Soil Tests for Determining "Available" Arsenic in Soils

J. H. Axley
Department of Agronomy

Purpose and Objectives

Arsenic compounds are still being used in agriculture. For this reason soils are being contaminated by arsenic.

The objectives of this project are:

1. To determine the chemical forms of arsenic in soils.
2. To develop, calibrate, and improve soil tests for determining the levels of available arsenic in soil.

Procedure

Arsenic was fractionated from known arsenic toxic and non-toxic soils from Maryland and other states according to the Peterson and Corey modification of the Chang and Jackson procedure for inorganic soil phosphorus fractions. This procedure was used because arsenic and phosphorus react about the same in soils.

The results of these chemical extractions were studied in reference to bioassays involving beans, corn and rye.

Results

Soils were found to have iron, aluminum and calcium arsenates, and the fractions vary in amount and concentration with different soils. These different arsenate fractions do not have the same toxicity to plants. The relative toxicity for the different chemical fractions of arsenate in the soil have been calculated. The results have not been completely analyzed and will be given in a future report.

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A method for determining calcium in solution by use of a calcium electrode has been developed and employed in this investigation. The method is very fast for determining calcium and gives excellent results.

Summary

Toxic arsenic soils were found to contain varying quantities of calcium, iron and aluminum arsenates. These quantities were related by an effectiveness factor for toxicity.

Micronutrient Requirements of Corn on Important Maryland Soils

J. H. Axley
Department of Agronomy

Purpose and Objectives

The objectives of this study were:

1. To study deficient, optimum, and toxic levels of copper, boron, manganese, and zinc in corn.
2. To study interrelationships of these micronutrients with other elements in plant nutrition.

Procedure

Two field experiments were established, one in Worcester County and the other in Prince George's County on the University of Maryland Plant Research Farm. The Worcester County experiment concerned the influence of nitrogen, potassium, manganese, zinc, boron, copper, and molybdenum on yield and stalk rot of corn. This was a randomized block experiment replicated 4 times. The other field experiment in Prince George's County was concerned with the influence of zinc, boron, copper, and molybdenum on the growth and yield of corn. This was also a randomized block field experiment which was replicated 5 times.

Results

The Worcester County experiment showed that on recently cleared land, corn yields were increased from 39 to 69 bu./acre with the application of 100-120-200 lbs./acre of N-P_2O_5-K_2O, respectively. Nitrogen at the 100 lb. rate gave 67 bu./acre and at the 200 lb. rate 68 bu./acre. Water was not thought to have limited yields as rainfall was 2.75" in May, 4.1" in June, 6.8" in July, and 4.6" in August.

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Lodging was related to fertilizer use as the number of stalks lodged in a 100 foot corn row were 8, 21, 29, respectively for no N, 100 lbs. of N, and 200 lbs. of N. Potash at the rate of 1000 lbs./acre did not decrease lodging when compared to a 200 lbs./acre rate.

In the same experiment micronutrients resulted in a range of lodged plants from 22 to 29 down stalks/100' of row; copper and manganese fertilized soils had low counts of 22 down stalks/100' of row. The copper fertilizer appeared to have caused some slight retardation in the growth of the corn plants which may have resulted in some reduction of lodged plants on this soil. Zinc, boron, and molybdenum did not seem to reduce lodging or increase yields on this new land.

In the Prince George's County experiment the influence of zinc, boron, copper, and molybdenum was determined on yields. The yield varied from an average of 52.9 bu./acre on the check plots to an average of 80.8 bu./acre on a zinc and boron treated plot. Yields were limited by lack of water towards the end of the growing season. Tissue analysis and future experimentation will help to determine if this type of fertilization will be meaningful in Maryland agriculture.

Summary

It was shown that nitrogen increases lodging when used excessively. Micronutrients did not reduce lodging, unless they were applied in sufficient amounts to reduce plant growth. Where boron and zinc are in short supply, yield increases in corn were noted when these elements were applied to the soil.

Using Wastes Formed in Vegetable and Cheese Production

J. H. Axley
Department of Agronomy

Purpose and Objectives

The objective of this study was to investigate the utilization of raw food materials, other than the portions processed and packaged as food, as a benefit for crop production.

Procedure

Tomato plant parts, roots, stems, green and red fruit were investigated for toxins. Two procedures were used, one in which seeds covered with a petri dish were germinated on filter paper which had been moistened with a water extract of plant tissue, and a new procedure that was developed by amending the "rag doll" test for use with plant tissue extracts. In both tests, seeds are germinated on paper with water extracts of plant, and the size and weight of the seedlings after a period of time indicates the biotoxicity of the plant extract.

Results

A method for a biological test was developed and used for the study of plant toxins (Table 1). It can be noted that the various tomato fractions reduced significantly the growth of the wheat except for the tomato roots.

Summary

A new procedure was developed by adapting the "rag doll" test for seed germination to a biological assay test for plant toxins.

By this test it was possible to show that tomato roots, vines, green fruit and ripe fruit contain different quantities of plant toxins per unit of dry wt.

Table 1. The influence of water extracts of tomatoes on the growth of wheat seedlings as indicated by root weight using a modified "rag doll" method.

Extract added	Root weight - gm.				
	Replicates				Mean
	1	2	3	4	
Distilled water	.095	.094	.087	.090	.092a+
Tomato vines	.073	.072	.077	.087	.077b
Tomato roots	.084	.087	.098	.095	.091a
Green tomatoes	.052	.048	.054	.056	.052c
Ripe tomatoes	.036	.042	.029	.039	.036d

+ Duncan's multiple range test has been applied to the data. Means followed by the same letter are not significantly different from each other at the 5% level.

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Distilled water	.093	.094	.087	.090	.092a+
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Tomato roots	.004	.007	.008	.005	.091a
Green tomatoes	.052	.048	.054	.056	.052a
Ripe tomatoes	.038	.042	.035	.039	.038d

+ Duncan's multiple range test has been applied to the data. Means followed by the same letter are not significantly different from each other at the 5% level.

Agricultural Waste Water Accommodations and Utilization by Various Forages

J. H. Axley
Department of Agronomy

Purpose and Objectives

The disposal of waste products from processing plants is a problem of major importance. The objective of this study was to compare the water assimilative capacity of various forages as a means of disposal of effluent from plants processing agricultural products.

Procedure

The experiment is comprised of three lines of sprinklers each of which applied a different rate (light, medium, heavy) of the effluent from a chicken processing plant to soils. Minimum rates in the light, medium, and heavy applications were 1.4, 1.7, and 2.1 inches per day, respectively, for an average of 2.5 days a week. On these soils are grown the forages listed in Table 1. The forages were harvested and yields were determined. The plant tissue was analyzed for nitrogen, phosphorus, and potassium. Effluent and soils also have been analyzed.

Results

The results in Table 1 show that tall fescue as a pure stand will give yields about equal to or better than any of the other grasses or combination of grasses studied. These grasses removed appreciable quantities of nitrogen from the effluent-treated soil as shown in Table 2. It can be noted that the legume-grass mixture contained considerably more nitrogen. Some of this nitrogen may have been received through the root nodule bacteria.

Studies of the chemical composition of the effluent from the plant and the estimated rate of irrigation suggest that the approximate nitrogen uptake by plants may be 10% of that applied.

Summary

Certain forages grow well when irrigated with large quantities of effluent. The most effective plants in this study removed from the soil (which is indirectly from the effluent) some 300 lbs. of nitrogen/acre. This quantity of nitrogen in the system represents, from our estimate of the quantity of effluent applied, about 10% of all the applied nitrogen.

Table 1. The influence of effluent application on the yield of several forage crops.

Forage Crop	Rate of Application					
	Light		Medium		Heavy	
	Yield tons/acre		Yield tons/acre		Yield tons/acre	
Tall fescue	4.59		3.59		5.43	
Reed canary grass	2.53		3.08		3.49	
Orchard grass	2.65		3.58		3.52	
Fescue, Orchard grass and Reed canary grass	2.76		3.87		2.77	
Tall fescue, Alsike and Ladino Clover	4.27		5.32		5.14	

Table 2. Nitrogen removed by several forage crops.

Forage Crop	Nitrogen removed, lbs. N/acre
Tall fescue	262.8
Reed canary grass	142.2
Orchard grass	139.5
Fescue, Orchard grass and Reed canary grass	137.8
Fescue, Alsike and Ladino Clover	305.8*

* Legumes may have received some of their nitrogen from root nodule bacteria.

Table 1. The influence of effluent application on the yield of several forage crops.

Forage Crop	Rate of Application		
	Light	Medium	Heavy
	Yield tons/acre	Yield tons/acre	Yield tons/acre
Tall fescue	4.57	3.59	5.45
Reed canary grass	2.53	3.08	3.49
Orchard grass	2.65	3.50	3.52
Fescue, Orchard grass and Reed canary grass	2.75	3.07	2.77
Tall fescue, Alsike and Ladino Clover	4.27	5.32	5.14

Table 2. Nitrogen removed by several forage crops.

Forage Crop	Nitrogen removed, lbs. N/acre
Tall fescue	282.8
Reed canary grass	142.2
Orchard grass	130.5
Fescue, Orchard grass and Reed canary grass	137.8
Fescue, Alsike and Ladino Clover	305.8*

* Legumes may have received some of their nitrogen from root nodule bacteria.

The Fate of Applied Fertilizer Nitrogen on Field Corn

J. H. Axley and J. O. Legg
Department of Agronomy and ARS, USDA

Purpose and Objectives

1. To determine the percent of applied nitrogen fertilizer taken up by corn plants.
2. To determine the amount of the applied nitrogen remaining in the soil at the end of the growing season.
3. To determine leaching losses of the applied nitrogen.

Procedure

One square foot of soil was fertilized with ^{15}N tag nitrogen in 18' x 21' plots treated with 30, 60, 90, 120, and 240 lbs. of nitrogen per acre. A no nitrogen treatment was also included. This randomized block experiment was replicated 4 times. It included two placement areas, one around a corn hill and between corn hills. Corn was check planted with hills on 3' centers.

Results

The plots have been harvested hill by hill and yields have been recorded. The plant samples have been ground and a ^{15}N analyses have been run. The results show that corn will take its nitrogen from the soil nearest the plant and go further only if more nitrogen is needed. Corn plants when utilizing applied nitrogen efficiently will take up about 54% of the applied nitrogen in the above ground portion of the plant.

Summary

A unique method has been developed to use the very costly ^{15}N in field tests at great reductions in price. Studies of this nature will show, under field conditions, how much of the applied fertilizer N enters the plant, how much stays in the soil, and how much is lost.

The Response of Corn to Monoammonium Phosphate (MAP) and to Ammonium Polyphosphate (APP) Using Several Methods of Placement

V. A. Bandel
Department of Agronomy

Purpose and Objectives

The objectives of this experiment were:

1. To compare the effectiveness of MAP and APP on corn yields and on rate of emergence.
2. To compare plant uptake of P from MAP and from APP at two stages of growth -- at 20 to 25 days after emergence and at the silking stage.
3. To compare the effectiveness of two corn fertilizers on yield, emergence, and phosphorus uptake when plowed down, placed in a band 2 inches to the side and 2 inches below the seed, and placed in direct contact with the seed.

Procedure

A split-plot design was used with 5 replications. Phosphorus sources were the main plots and placement methods were the sub-plots. There were 2 phosphorus sources (MAP and APP), 5 placement treatments, and a phosphorus check. With 5 replicates, there were a total of 60 plots each measuring 15 by 50 feet. The treatments are listed in Table 1.

The plow-down fertilizer was applied on April 3. On April 18, a single cross hybrid corn (Pioneer 3306) was planted in 30 inch rows at an anticipated population of 18,000 plants per acre. An E-Z Flow granular herbicide attachment on the planter was used to apply the pop-up fertilizer. The corn was sidedressed with 75 lb/A of nitrogen on June 10.

Atrazine was applied at about 2 lb/A as a preemergence weed control. Nutgrass and foxtail, however, became a serious problem and were hoed on

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The plow-down fertilizer was applied on April 3. On April 18, a single cross hybrid corn (Pioneer 3306) was planted in 30 inch rows at an anticipated population of 18,000 plants per acre. An 8-2 Plow granular herbicide attachment on the planter was used to apply the pop-up fertilizer. The corn was sidedressed with 75 lb/A of nitrogen on June 10.

Atrazine was applied at about 2 lb/A as a preemergence weed control. Nutgrass and foxtail, however, became a serious problem and were hoed on

June 5 and 6. Those weeds that remained were controlled with 2 spray applications of 2 lb/A of atrazine and 1 gal/A of non-phytotoxic oil. The corn suffered some temporary burning injury on the leaves from this treatment.

The height of the corn plants was measured on June 14. Whole plant samples were taken on June 21 when the plants were 16 to 30 inches tall. Ear leaf samples were taken on July 17 at the tasseling stage. The corn was harvested on October 1. Plant samples were analyzed for phosphorus, potassium, calcium, and magnesium.

Results

The rate of emergence was not noticeably affected by any of the treatments. But, from the time the corn was approximately 6 to 12 inches tall until early tasseling, the corn plants that had received some starter fertilizer in the row grew faster than those plants which had not received the starter fertilizer. The plant height was measured on June 14 and is given in Table 2.

Plant height was increased by about 4 inches from row fertilizer at the time of measurement. Maximum early growth occurred when there was some fertilizer in the row, regardless of whether it was placed 1) in direct contact with the seed (pop-up), or 2) in the more conventional manner approximately 2 inches beside and 2 inches below the seed, or 3) in a combination of 1) and 2). The elimination of plow-down phosphorus and no row fertilizer caused the most severe reduction in early growth. This severe reduction was essentially corrected by the "pop-up" treatment. The corn grew out of these visible differences by tasseling time. A soil test of the plot area indicated a high phosphorus level (165 H) which may account for the gradual elimination of differences in height between the treatments

as root systems expanded and came into contact with more of the soil phosphorus.

Stand counts taken at harvest indicate that there may have been some reduction in stand as a result of the "pop-up" (Table 3). But, although there were significant differences between some of the placement means, significant stand reductions did not occur every time "pop-up" was used. This aspect will be examined further in 1969.

Phosphorus uptake was reduced in the whole plant in those treatments where no phosphorus was plowed down. A small amount of "pop-up" in the row apparently did not raise the phosphorus level during early growth (Table 4).

There were significant differences in P uptake due to placement, but the trends again are not clear. Apparently, initial phosphorus uptake was restricted in those plots where no phosphorus was plowed down. Phosphorus uptake did not seem to be improved by the "pop-up" treatment. Total P uptake was probably increased by the "pop-up" treatment because of the increased growth observed. But total uptake was not measured. Leaf samples taken at tasseling time indicated that the original differences in P uptake were overcome (Table 5).

The treatments had no effect upon early uptake and ear leaf content of potassium, calcium, and magnesium. Nor were there any differences in yields as a result of treatment (Tables 6, 7, 8, 9, 10, 11, and 12).

Summary

In this test, corn did not respond any better to ammonium polyphosphate than it did to monoammonium phosphate. The only noticeable response to fertilizer placement and to phosphorus occurred in the early growth. Placement did not seem to influence rate of emergence, but it did influence early

growth. There was a big difference in early growth between those plots receiving row fertilizer and those which did not. This response occurred despite the fact that the soil tested high in phosphorus and magnesium and medium in potassium. It made little difference whether the row application was put on as a "pop-up" or as the conventional placement.

Yields were not increased by phosphorus source nor by method of placement.

The results of this test indicate that row fertilizer is essential for early corn growth even on medium to high fertility soils. But row fertilizer did not increase yields in this case. On poorer soils, row applications would probably increase yields. "Pop-up" fertilizer properly applied seems to be equivalent to the more conventional methods of application.

Table 1. Fertilizer treatments.

Tmt. No.	Plow Down	Band	Pop-up	Side Dress	P Source[1]
1	70-115-125	----	----	75-0-0	MAP
2	70-0-125	----	----	75-0-0	MAP
3	70-0-125	----	3-12-3	75-0-0	MAP
4	55-55-110	15-60-15	----	75-0-0	MAP
5	70-115-125	----	3-12-3	75-0-0	MAP
6	55-55-110	15-60-15	3-12-3	75-0-0	MAP
7	70-115-125	----	----	75-0-0	APP
8	70-0-125	----	----	75-0-0	APP
9	70-0-125	----	3-12-3	75-0-0	APP
10	55-55-110	15-60-15	----	75-0-0	APP
11	70-115-125	----	3-12-3	75-0-0	APP
12	55-55-110	15-60-15	3-12-3	75-0-0	APP

[1]MAP - monoammonium phosphate, APP - ammonium polyphosphate.

Table 2. The effect of phosphorus source and fertilizer placement on height of plants 6/14/68.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
				Inches			
MAP	13.5	9.8	16.2	17.2	19.0	19.5	15.9
APP	15.8	10.5	18.5	18.0	17.5	19.8	16.7
Ave.	14.6	10.2	17.4	17.6	18.2	19.6	

*See Table 1 for explanation of treatments.

Table 1. Fertilizer treatments.

Trt. No.	Plow Down	Band	Top-up	Side Dress	P Source[1]
1	70-115-125	----	----	75-0-0	MAP
2	70-0-125	----	----	75-0-0	MAP
3	70-0-125	----	3-12-3	75-0-0	MAP
4	55-55-110	15-60-15	----	75-0-0	MAP
5	70-115-125	----	3-12-3	75-0-0	MAP
6	55-55-110	15-60-15	3-12-3	75-0-0	MAP
7	70-115-125	----	----	75-0-0	APP
8	70-0-125	----	----	75-0-0	APP
9	70-0-125	----	3-12-3	75-0-0	APP
10	55-55-110	15-60-15	----	75-0-0	APP
11	70-115-125	----	3-12-3	75-0-0	APP
12	55-55-110	15-60-15	3-12-3	75-0-0	APP

[1]MAP - monoammonium phosphate, APP - ammonium polyphosphate.

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Phosphorus Source*	Treatment Number						Ave.
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	
	Inches						
MAP	13.5	9.8	16.2	17.2	19.0	12.5	15.0
APP	15.8	10.5	18.5	18.0	17.5	19.8	16.7
Ave.	14.6	10.2	17.4	17.6	18.2	16.2	15.8

*See Table 1 for explanation of treatments.

Table 3. The effect of phosphorus source and fertilizer placement on corn plant population.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
	Plants/Acre						
MAP	17417	17672	17328	19172	16725	17678	17665
APP	19520	18282	18025	18432	15160	15765	17531
Ave.**	18469	17978	17676	18802	15942	16721	

* See Table 1 for explanation of treatments.
**Significant at 1% level. LSD .05 = 1460 stalks. CV = 8.1%

Table 4. The effect of phosphorus source and fertilizer placement on phosphorus content of whole corn plants.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
	%						
MAP	0.36	0.32	0.30	0.37	0.33	0.30	0.33
APP	0.36	0.32	0.30	0.37	0.35	0.32	0.34
Ave.**	0.36	0.32	0.30	0.37	0.34	0.31	

* See Table 1 for explanation of treatments.
**Significant at the 1% level. LSD .05 = 0.02%P, CV = 5.8%.

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Phosphorus Source*	Treatment Number						
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
	Plants/Acre						
MAP	17417	17672	17728	19172	16725	17678	17665
APP	18520	18282	18025	18432	15160	18765	17531
Ave.**	18469	17970	17876	18802	15942	18721	

* See Table 1 for explanation of treatments.
**Significant at 1% level. LSD .05 = 1650 stalks. CV = 8.1%

Table 4. The effect of phosphorus source and fertilizer placement on phosphorus content of whole corn plants.

Phosphorus Source*	Treatment Number						
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
	%						
MAP	0.36	0.32	0.30	0.37	0.33	0.30	0.33
APP	0.35	0.32	0.30	0.37	0.35	0.32	0.34
Ave.**	0.36	0.32	0.30	0.37	0.34	0.31	

* See Table 1 for explanation of treatments.
**Significant at the 1% level. LSD .05 = 0.02%. CV = 5.0%.

Table 5. The effect of phosphorus source and fertilizer placement on phosphorus content of corn ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	0.31	0.30	0.30	0.33	0.31	0.33	0.31
APP	0.30	0.30	0.32	0.32	0.31	0.32	0.31
Ave.	0.31	0.30	0.31	0.33	0.31	0.32	

*See Table 1 for explanation of treatments.

Table 6. The effect of phosphorus source and fertilizer placement on potassium content of whole corn plants.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	6.5	6.4	6.1	6.5	6.2	6.6	6.4
APP	6.3	6.0	6.2	6.4	6.1	6.1	6.2
Ave.	6.4	6.2	6.2	6.4	6.1	6.4	

*See Table 1 for explanation of treatments.

Table 7. The effect of phosphorus source and fertilizer placement on calcium content of whole corn plants.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	.58	.56	.57	.57	.60	.58	.58
APP	.57	.56	.58	.61	.60	.59	.58
Ave.	.57	.56	.57	.59	.60	.59	

*See Table 1 for explanation of treatments.

Table 8. The effect of phosphorus source and fertilizer placement on magnesium content of whole corn plants.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	.37	.52	.40	.36	.40	.36	.40
APP	.44	.49	.36	.40	.41	.37	.41
Ave.	.40	.50	.38	.38	.40	.36	

*See Table 1 for explanation of treatments.

Table 9. The effect of phosphorus source and fertilizer placement on potassium content of corn ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	2.2	2.2	2.0	2.2	2.1	2.2	2.2
APP	2.1	2.2	2.2	2.2	2.1	2.2	2.2
Ave.	2.2	2.2	2.1	2.2	2.1	2.2	

*See Table 1 for explanation of treatments.

Table 10. The effect of phosphorus source and fertilizer placement on content of corn ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	.69	.68	.70	.72	.69	.75	.70
APP	.69	.68	.71	.72	.73	.68	.70
Ave.	.69	.68	.70	.72	.71	.71	

*See Table 1 for explanation of treatments.

Table 9. The effect of phosphorus source and fertilizer placement on potassium content of corn ear leaf samples.

Phosphorus Source*	Treatment Number						Ave.
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	
	%						
MAP	2.3	2.2	2.0	2.2	2.1	2.2	2.2
APP	2.1	2.2	2.2	2.2	2.1	2.2	2.2
Ave.	2.2	2.2	2.1	2.2	2.1	2.2	

*See Table 1 for explanation of treatments.

Table 10. The effect of phosphorus source and fertilizer placement on content of corn ear leaf samples.

Phosphorus Source*	Treatment Number						Ave.
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	
	%						
MAP	.69	.68	.70	.72	.69	.73	.70
APP	.69	.68	.71	.72	.73	.68	.70
Ave.	.69	.68	.70	.72	.71	.71	

*See Table 1 for explanation of treatments.

Table 11. The effect of phosphorus source and fertilizer placement on magnesium content of corn ear leaf samples.

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			%				
MAP	.32	.30	.31	.33	.31	.34	.32
APP	.30	.32	.33	.34	.33	.32	.32
Ave.	.31	.31	.32	.33	.32	.33	

*See Table 1 for explanation of treatments.

Table 12. The effect of phosphorus source and fertilizer placement on corn grain yields (15.5% H_2O)

Phosphorus Source*	Treatment Number 1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
			Bu/A				
MAP	124.8	113.7	120.6	126.7	108.1	126.0	120.0
APP	126.5	131.8	124.5	124.0	116.4	122.1	124.2
Ave.	125.7	122.8	122.6	125.3	112.3	124.1	

*See Table 1 for explanation of treatments.

Table 11. The effect of phosphorus source and fertilizer placement on magnesium content of corn ear leaf samples.

Phosphorus Source*	Treatment Number						
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
	%						
MAP	.32	.30	.31	.33	.31	.34	.32
APP	.30	.32	.33	.34	.32	.32	.32
Ave.	.31	.31	.32	.33	.32	.33	

*See Table 1 for explanation of treatments.

Table 12. The effect of phosphorus source and fertilizer placement on corn grain yields (15.5% H_2O)

Phosphorus Source*	Treatment Number						
	1 & 7	2 & 8	3 & 9	4 & 10	5 & 11	6 & 12	Ave.
	Bu/A						
MAP	124.8	119.7	120.6	125.7	130.1	126.0	120.0
APP	126.5	131.8	124.5	126.0	116.4	122.1	124.2
Ave.	125.7	122.0	122.6	125.3	123.3	124.1	

*See Table 1 for explanation of treatments.

The Response of Corn to Fall vs. Spring Plowing, Broadcast vs. Plow-down Fertilizer, and Fall vs. Spring Fertilization

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Purpose and Objectives

The objectives of this experiment are:

1. To compare the effects of fall vs. spring plow-down of various forms of nitrogen on corn yields and nutrient recovery.
2. To compare fall plowing with spring plowing on corn yields and nutrient recovery.
3. To compare plow-down fertilizers to disced-in fertilizers on corn yields and nutrient recovery.

Procedure

This project was conducted at four locations: 1) Plant Research Farm, Fairland, 2) Wye Institute, Queenstown, 3) Worcester Vocational Center, Snow Hill, and 4) George Redman Farm, Chestertown. Four sources of nitrogen (urea, ammonium sulfate, ammonium nitrate, and sodium nitrate) in a complete fertilizer were applied in a replicated split plot design. The main plots were 1) fall plow-down, and 2) spring plow-down at all locations except the Plant Research Farm where 3) plow in fall, disc-in fertilizer in spring, and 4) plow in spring, disc-in fertilizer in spring were also included. The four nitrogen sources plus no nitrogen (check) were the sub-plots. Nitrogen was broadcast on all plots except the check at a rate of 120 lb/A, whereas P_2O_5 and K_2O were applied at 80 lb/A. All plots received a uniform fertilizer application in the row. The fall applied fertilizer was broadcast soon after soil temperatures fell to 45° F. Fall and spring fertilizer was applied between November 16 and November 29 and April 3 and April 18, respectively.

The hybrid corn varieties seeded at each location were Pioneer 3306 at Fairland and Queenstown, DeKalb XL-45 at Chestertown, and Asgrow 95 at Snow Hill.

Results

The grain yields obtained for the Queenstown, Snow Hill, and Chestertown locations are given in Tables 1, 2, and 3.

Grain yields at Snow Hill were not significantly influenced by time or the source of nitrogen (Table 2). There was not even a significant difference between the check and the nitrogen treatment. Until the corn was about 30 inches tall, nitrogen deficiencies were apparent on the check and fall plow-down plots. The plants grew out of this problem. This test was located on a Matapeake loam (almost a sandy loam) and will be continued on the same area in 1969.

Grain yields at Queenstown were not influenced by time of nitrogen application nor by nitrogen source (Table 1). There was a significant increase due to 140 lbs. of nitrogen vs. no nitrogen plowed down.

The largest differences in yields occurred at the Chestertown location (Table 3). Because of hot, dry weather during the summer of 1968, the plots only averaged 58 bu/A. There was an average loss of 16 bu/A from the fall nitrogen application compared to the spring treatment. Of the four nitrogen sources applied in the fall, urea performed best and nitrate of soda performed the worst. There was about a 7 bu/A loss from the fall applied urea, but a 28 bu/A loss from the nitrate of soda. Losses from ammonium sulfate and ammonium nitrate were between these two extremes.

This test was also carried out in 1967 on the same location with no differences in yields occurring (Table 4). Apparently, there was sufficient residual fertility (nitrogen) in the soil (a Sassafras loam) the first year

to produce a good yield without additional fertilizer. The fertility level was then pulled down sufficiently the first year, that with the addition of no further plant food on the check plots, and with leaching occurring on the fall fertilized plots, yield differences became apparent in 1968.

Summary

Corn yields were not reduced by fall application of a complete fertilizer on first year locations. At one location, which had been treated the previous year, fall application of some forms of nitrogen reduced yields when compared to spring applications. Urea seemed to be retained over the winter better than ammonium nitrate and ammonium sulfate, which were retained better than nitrate of soda. Apparently, winter loss of nitrate nitrogen can be serious on some soils. Some urea can also be lost over winter, but the amount is insignificant compared to nitrate nitrogen.

Table 1. The effect of fall and spring applied nitrogen on corn grain yields at Queenstown - 1968.

Time of Application	Nitrogen Source: Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average	Check[1]
	bu/A (15.5% H_2O)					
Fall Plow-down	91.8	83.8	94.0	87.9	89.4	78.4
Spring Plow-down	98.0	85.2	93.3	92.6	92.3	69.6
Average	94.9	84.5	93.6	90.2		74.0

[1]No nitrogen plowed down.

Table 2. The effect of fall and spring applied nitrogen on corn grain yields at Snow Hill - 1968.

Time of Application	Nitrogen Source: Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average	Check[1]
	bu/A (15.5% H_2O)					
Fall Plow-down	125.5	123.1	126.6	114.6	117.4	106.4
Spring Plow-down	133.0	139.6	119.6	126.0	129.5	118.3
Average	129.2	131.4	123.1	120.3		112.3

[1]No nitrogen plowed down.

Table 3. The effect of fall and spring applied nitrogen on corn grain yields at Chestertown - 1968.

Time of Application	Nitrogen Source: Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average	Check[1]
	bu/A (15.5% H_2O)					
Fall Plow-down	65.0	49.6	54.1	44.6	53.3	37.3
Spring Plow-down	72.0	72.8	61.0	72.4	69.5	46.7
Average	68.5	61.2	57.5	58.6		42.0

[1]No nitrogen plowed down.

Table 4. The effect of fall and spring applied nitrogen on corn grain yields at Chestertown - 1967.

Time of Application	Nitrogen Source: Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average	Check[1]
	bu/A (15.5% H_2O)					
Fall Plow-down	128.2	125.8	122.0	125.0	125.3	101.8
Spring Plow-down	129.0	132.2	129.1	131.4	130.4	97.1
Average	128.6	129.0	125.5	128.2		99.5

[1]No nitrogen plowed down.

Table 3. The effect of fall and spring applied nitrogen on corn grain yields at Chesterton - 1956.

Time of Application	Nitrogen Source: Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average	Check[1]
	bu/A (15.5% H_2O)					
Fall Plow-down	65.0	49.6	54.1	44.6	53.3	37.3
Spring Plow-down	72.0	72.8	61.0	72.4	69.5	46.7
Average	68.5	61.2	57.5	58.6		42.0

[1] No nitrogen plowed down.

Table 4. The effect of fall and spring applied nitrogen on corn grain yields at Chesterton - 1957.

Time of Application	Nitrogen Source: Urea	Ammonium Sulfate	Ammonium Nitrate	Sodium Nitrate	Average	Check[1]
	bu/A (15.5% H_2O)					
Fall Plow-down	128.2	125.0	122.0	125.0	125.3	101.0
Spring Plow-down	129.0	132.2	125.1	131.4	129.4	97.1
Average	128.6	129.0	123.5	128.2		99.5

[1] No nitrogen plowed down.

The Influence of Phosphorus and Potassium on Yield and Yield Components of Two "Responding" and Two "Non-responding" Soybean Varieties

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Purpose and Objectives

Recently, several varieties and selections of soybeans have been shown to differentially respond to applications of P and K. If some of these traits can be selected and bred into existing varieties, then varieties responsive to today's rates of fertilization may evolve. Thus, the following objectives were selected:

1) Study the influence of P and K application on yield response of two "responsive" and two "non-responsive" soybean varieties.

2) Study the influence of P and K application on lodging, height, seed size, and seed quality of these varieties.

Procedure

A completely randomized 4 x 3 x 3 factorial design was initiated in the spring of 1968 at the Wye Institute with 4 varieties and 3 levels of P and K. The site was located on Mattapex silt loam and contained the following treatments:

Phosphorus:
- P_1 = None
- P_2 = 200 lbs. P_2O_5/A as 0-20-0
- P_3 = 400 lbs. P_2O_5/A as 0-20-0

Potassium:
- K_1 = None
- K_2 = 200 lbs. K_2O/A as 0-0-60
- K_3 = 400 lbs. K_2O/A as 0-0-60

Varieties:
- V_1 = Delmar
- V_2 = Clark — responding
- V_3 = Kent
- V_4 = Bethel — non-responding

Additional plot information:
- Replications: 4
- Plot Size: 10' x 22'
- Total Plot Area 176' x 180'
- Total Plots: 144
- Planting Date: 5-22-68
- Seeding Rate: 7.5 seeds/ft.
- Row Width: 30'
- Weed Control: Dacthal (0.7 lbs/A) pre-plant.

Varieties were selected according to previous studies in Maryland which showed Delmar and Clark responsive to added fertilizer while Kent and Bethel were not. Fertilizer was applied early in April and incorporated into the soil. Four weeks after planting, plants were thinned to approximately 7 per linear foot.

Yield was determined from the two center 16-foot rows. Seed size, seed quality, protein, and oil analysis were determined. The statistical factorial design was analyzed by the BMDO2V program at the Computer Science Center, University of Maryland.

Results

Statistical analyses for the factorial design are shown in Tables 1 and 2.

Kent out-yielded all other varieties at 37.0 bu. per acre. Bethel, which showed the greatest height of 40.3", displayed the greatest degree of lodging. Seed size was largest for Delmar. Seed quality was poorest for Kent.

Looking at the significance of main effect and interactions, the greatest differences are within varieties. The V x P interaction for yield was largely due to differences in varieties with only a slight response (1 bu.) to P application. The greatest variety response to P was from Kent which showed a 4 bu. response from 400 lbs. P_2O_5. Other varieties showed little response to P application. The significant P x K interaction for seed size showed that seed size increased with higher levels of P and decreased with higher levels of K. The V x P interaction for seed quality was due largely to varieties; however, P application did improve seed quality somewhat.

Increasing P levels increases the degree of lodging when all varieties are considered. Bethel showed this trend to a greater extent than other varieties. Addition of K decreased lodging (10% level) when all varieties were considered. However, the greatest response was found for Clark.

Summary

Few differences in yield response were obtained between the "responding" and "non-responding" varieties. Kent was the only variety that showed any substantial response to P. Statistical comparison between individual varieties and within response categories are yet to be made. However, it appears that P and K response will not follow the "responsive" and "non-responsive" categories initially established.

In general, K application reduced lodging while P improved seed quality and increased seed size. In the P x K interaction, K decreased seed size. The significant V x P interactions were due largely to differences in varieties.

Table 1. Factorial analysis for yield, height, seed size, seed quality, and lodging of four soybean varieties.

Variety	Yield** bu/A	Height[1]** inches	Seed Size** g/100 seeds	Seed Quality[2]*	Lodging[3]**
Delmar	34.2	36.4	15.6	2.28	1.26
Clark	36.0	33.3	14.3	2.14	1.36
Kent	37.0	34.1	15.3	2.44	1.17
Bethel	34.3	40.3	15.2	2.14	1.59

Average of 4 replications over 3 levels of P and K.

* 5% level ** 1% level

[1]measured prior to harvest.
[2]relative scale of 0-5 with 0 as perfect.
[3]relative scale of 0-5 with 0 as erect.

Table 2. Main effect and interactions of varieties, phosphorus, and potassium for five measured parameters.

Parameter measured	Significance of main effect and interactions						
	V	P	K	VP	VK	PK	VPK
Yield	**	--	--	**	--	--	---
Height	**	--	--	--	--	--	---
Seed size	**	--	--	--	--	*	---
Seed quality	*	--	--	*	--	--	---
Lodging	**	*	10%	--	--	--	---

V = variety
P = phosphorus
K = potassium

Differences between varieties were significant for all parameters measured.

Table 1. Factorial analysis for yield, height, seed size, seed quality, and lodging of four soybean varieties.

Variety	Yield** bu/A	Height1** inches	Seed Size** g/100 seeds	Seed Quality2*	Lodging3**
Delmar	34.2	36.4	15.6	2.29	1.26
Clark	36.0	33.3	14.3	2.14	1.36
Kent	37.0	34.1	15.3	2.44	1.17
Bethel	34.3	40.3	15.2	2.14	1.59

Average of 4 replications over 3 levels of P and K.

* 5% level ** 1% level

[1]measured prior to harvest.

[2]relative scale of 0-5 with 0 as perfect.

[3]relative scale of 0-5 with 0 as erect.

Table 2. Main effect and interactions of varieties, phosphorus, and potassium for five measured parameters.

Parameter measured	Significance of main effect and interactions						
	V	P	K	VP	VK	PK	VPK
Yield	**	--	--	**	--	--	--
Height	**	--	--	--	--	--	--
Seed size	**	--	--	--	--	*	--
Seed quality	*	--	--	*	--	--	--
Lodging	**	*	10%	--	--	--	--

V = variety
P = phosphorus
K = potassium

Difference between varieties were significant for all parameters measured.

The Influence of Soil Organic Nitrogen and Other Properties on Soybean Growth

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Department of Agronomy

Purpose and Objectives

Soybeans are known to produce well under "high fertility" conditions but not under conditions of "low fertility" even when adequate fertilizer nutrients are applied. Thus, soybeans appear to respond more to residual fertilizer nutrients applied to previous crops rather than from direct application. In this regard, "high fertility" and "high fertilization" are not the same. The entire soil physical, chemical, and biological environment determine "soil fertility".

Although soybeans are a legume, the plant nitrogen requirements are partially fulfilled by the soil. Therefore, the nitrogen fraction of the soil may be important in defining what is often called a "high fertility" soil in soybean production. It seems logical to look at both the soil organic and inorganic nitrogen fractions in a situation where soybean yield, soil tests, and plant analyses can all be correlated. The objectives of this study were to:

1) Determine if certain soil organic nitrogen fractions influence soybean productivity.
2) Correlate plant nutrient levels in plant tissue with soybean yield and soil test results.
3) Study the distribution of Rhizobium japonicum serological groups within two soil types.

Procedure

Twenty soybean fields were selected throughout Dorchester and Somerset Counties from two soil types: Sassafras sandy loam and Matapeake silt loam. These soil types were selected because they are somewhat typical of the contrast between the heavy and light textured soils on the Eastern Shore. Sites were selected by the county agents[1] on the basis that the farmers were good cooperators and good managers. A uniform area of 60' x 60' was selected as the sampling site.

Soybeans were planted by conventional methods. Both full season - and after barley - beans were studied since it was difficult to find all full season soybeans on these soil types.

Soil and plant tissue samples were taken early in July when the soybeans were in the fourth trifoliate stage. Samples were taken from the upper-most developed leaves (blade and petiole) and analyzed for N, P, Ca, Mg, Zn, Fe, Mn, Cu, and S.

Soil samples were taken from both the surface (Ap) and subsoil (B) within the sampling site. Analysis by the soil testing laboratory included pH, Ca, P, and K. Various components of organic nitrogen were analyzed by extraction and autoclaving procedures.

Plant samples were taken again in late July from the top and bottom portions of the plant between growth stages 4 and 6. The upper-most, recently-matured petioles and lower-matured petioles were sampled and analyzed as in the first sampling.

The last sampling was taken in late August when the plants were near maturity. Both top and bottom portions were taken as for the second sampling. Soil samples from only the surface (Ap) were taken at this time.

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[1]The author is indebted to R. L. Johnson and L. R. Wade for their assistance in locating sites.

Soybean nodules for serological grouping were sampled early in September by removing all the nodules from five plants at two different locations within the sampling site. Forty-five nodules were sero-typed against six Beltsville serogroups. Fifteen nodules were later typed against 12 serogroups. This information was correlated against soybean yield and various soil tests.

Soybean yield was determined at maturity and correlated against various plant and soil analyses by multiple correlation on the BIMD-29 program at the Computer Science Center, University of Maryland.

Results

Multiple correlation and chemical analyses for all the parameters have not been completed. However, linear correlation for soil pH and soybean yield are shown in Figure 1. Good correlation between soil pH and yield was obtained for both the first and third sampling. The correlation coefficient for Sassafras sandy loam was 0.788 which was significant at the 1% level. Similar correlation was obtained for the first sampling. Relation of yield with pH for the subsoil (B) was not significant. Good correlation of pH with yield was also obtained for Matapeake silt loam. It should be noted that the slope for Matapeake is large; however, two sites contribute largely to this slope. Soybean yields were higher for the Matapeake soil, reaching 57.5 bushels per acre. Correlation of yield with pH (B) was not significant.

Distribution of serological groups for nodules taken from these sites is shown in Table 1. It is apparent that there is considerable variation in distribution of groups within individual soil types. Serogroup 122 is dominant for both soils, but varies considerably within each soil type. Strains 76 and 94 produce plant chlorosis on some genotypes in the field, but may not reduce yield. Further correlation of the data will determine

this. Strains 110, 122, and 125 are known to be quite efficient when compared with some of the background strains. Correlation of strain predominence with yield and soil parameters should show if a particular serogroup influences yield and what soil factors influence serogroup. No major differences in serogroup between soil types were noted, although the portion of nodules not identified was larger for the Matapeake soil. The non-identified nodules were later found to contain serogroups 31, 38, 6, 112, 130, 4, 72, and 124.

Summary

The complete significance of the pH correlation with soybean yield will require more statistical information. It is apparent that soil pH is a critical factor in determining soybean yield and that lime should be given high consideration in soybean production. However, soil pH manifests itself with other chemical, physical, and biological properties of the soil. Therefore, multiple correlation with plant analysis should determine whether the yield response with pH is due alone to increased Ca and Mg or to combination of other factors. These data will be available shortly.

Correlation of soil organic nitrogen with yield and serological groups is currently underway. Although a large difference in serological groupings between the two soils was not evident, individual soils varied considerably.

Studying the correlation of soybean yield with various parameters within individual soil types should reflect the influence of agronomic practices to a greater extent than if various soil types were used. Thus, a goal of this study is to define more clearly what factors influence soybean yield within individual soil types.

Table 1. Distribution of Rhizobium japonicum serological groups* for nodules taken from two soil types.

Sassafras Sandy Loam (Serogroup (%)							
125	110	122	94	76	46	123	Other
6.7	11.1	28.9	15.5	6.7	13.3	0	17.8
4.4	2.2	22.2	6.7	31.1	17.7	6.7	9.0
2.2	4.4	4.4	17.8	28.9	15.5	13.3	13.5
6.7	20.0	15.5	8.9	8.9	13.3	0	26.7
0	11.1	8.9	8.9	17.8	11.1	6.7	38.5
0	11.1	22.2	4.4	8.9	8.9	0	44.5
4.4	0	35.5	4.4	11.1	15.5	0	29.1
17.7	0	6.7	13.3	17.8	20.0	24.4	0
0	6.7	30.1	2.2	2.2	8.9	35.5	14.4
4.4	8.8	11.1	17.8	6.6	22.2	6.6	22.5
Ave. 4.7	7.5	18.6	10.0	14.0	14.6	9.3	21.3

Metapeake Silt Loam Serogroup (%)							
125	110	122	94	76	46	123	Other
6.7	13.3	11.2	13.3	6.2	8.9	2.2	37.7
13.3	13.3	11.1	0	0	4.4	28.9	19.0
0	6.7	17.8	4.4	6.7	6.7	15.5	42.2
6.7	2.2	8.9	2.2	13.3	13.3	0	53.4
8.9	8.9	4.4	35.5	4.4	2.2	0	35.7
4.4	6.7	15.5	8.9	4.4	2.2	6.7	51.2
2.2	0	8.9	0	4.4	11.1	24.4	49.1
6.7	4.4	24.4	2.2	11.1	15.5	11.1	24.6
6.7	8.9	13.3	11.1	13.3	24.4	15.5	6.8
Ave. 6.2	7.2	12.8	8.6	6.5	9.9	11.6	35.5

* Beltsville Serological Groups - 45 nodules/observation.

The author is indebted to Dr. D. Weber and V. Miller, Soybean Investigations, USDA, Beltsville, Maryland for providing the serological material and information.

Table 1. Distribution of *Bradyrhizobium japonicum* serological groups* for nodules taken from two soil types.

Sassafras Sandy Loam (Serogroup (%)						
125	110	122	94	76	46	123	Other
6.7	11.1	28.9	15.5	5.7	13.3	0	17.8
4.4	2.2	22.2	6.7	31.1	17.7	6.7	9.0
2.2	4.4	4.4	17.8	28.9	15.5	13.3	13.3
6.7	20.0	15.5	8.9	8.9	13.3	0	26.7
0	11.1	8.9	8.9	17.8	11.1	6.7	26.5
0	11.1	22.2	4.4	8.9	8.9	0	44.5
4.4	0	35.5	4.4	11.1	15.5	0	28.1
17.7	0	8.7	13.3	17.8	20.0	24.4	0
0	6.7	30.1	2.2	2.2	8.9	35.5	14.4
4.4	8.8	11.1	17.8	6.6	22.2	6.6	22.5
Ave. 6.7	7.5	18.6	10.0	14.0	14.6	9.5	21.3

Hecapeake Silt Loam Serogroup (%)						
125	110	122	94	76	46	123	Other
6.7	13.3	11.2	13.3	6.2	8.9	2.2	37.2
13.3	13.3	11.1	0	0	4.4	28.9	15.0
0	6.7	17.8	4.4	6.7	6.7	15.5	42.2
6.7	2.2	8.9	2.2	13.3	13.3	0	53.4
8.9	8.9	4.4	35.5	4.4	2.2	0	35.7
4.4	6.7	15.5	8.9	4.4	2.2	6.7	51.2
2.2	0	8.9	0	6.6	11.1	24.4	46.1
6.7	4.4	24.4	2.2	11.1	15.5	11.1	24.6
6.7	8.9	13.3	11.1	13.3	24.4	15.5	6.8
Ave. 6.2	7.2	12.8	8.6	6.5	8.9	11.6	35.2

* Beltsville Serological Groups - 45 nodules/observation.

The author is indebted to Dr. D. Weber and V. Miller, Soybean Investigations, USDA, Beltsville, Maryland for providing the serological material and information.

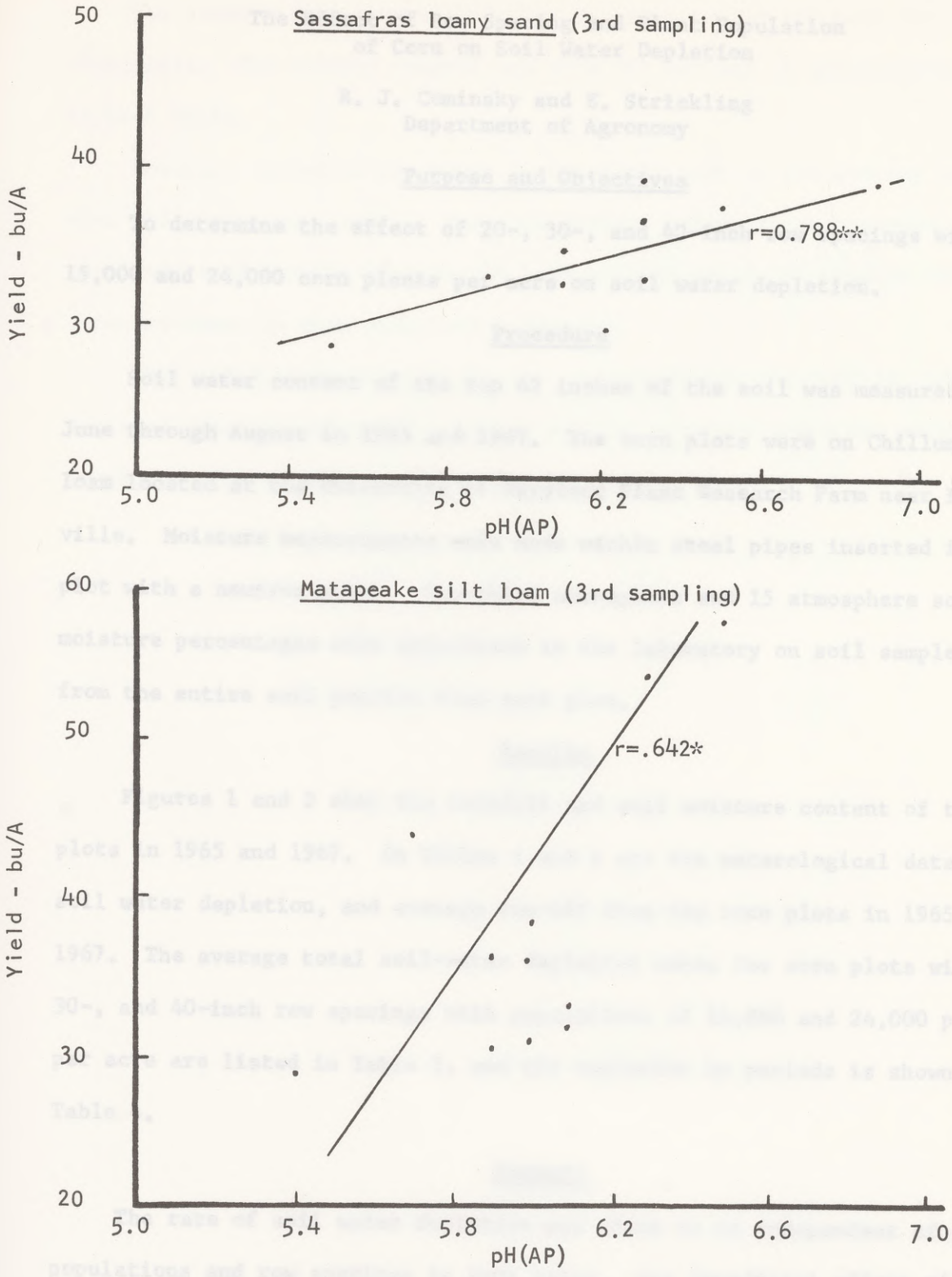

Figure 1 -- Linear correlation of soil pH with soybean yield for Sassafras sandy loam and Matapeake silt loam.

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The Effect of Row Spacing and Plant Population of Corn on Soil Water Depletion

R. J. Cominsky and E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the effect of 20-, 30-, and 40-inch row spacings with 15,000 and 24,000 corn plants per acre on soil water depletion.

Procedure

Soil water content of the top 42 inches of the soil was measured from June through August in 1965 and 1967. The corn plots were on Chillum silt loam located at the University of Maryland Plant Research Farm near Beltsville. Moisture measurements were made within steel pipes inserted in each plot with a neutron probe. One-third atmosphere and 15 atmosphere soil moisture percentages were determined in the laboratory on soil samples taken from the entire soil profile from each plot.

Results

Figures 1 and 2 show the rainfall and soil moisture content of the corn plots in 1965 and 1967. In Tables 1 and 2 are the meterological data, average soil water depletion, and average run-off from the corn plots in 1965 and 1967. The average total soil-water depletion rates for corn plots with 20-, 30-, and 40-inch row spacings with populations of 15,000 and 24,000 plants per acre are listed in Table 3, and the depletion by periods is shown in Table 4.

Summary

The rate of soil water depletion was shown to be independent of plant populations and row spacings in both years. Any beneficial effect of reduced evaporation caused by shading of the soil surface by the planting patterns did not reduce the rate of soil water depletion. The average soil water depletion rate was 0.12 inch per day for all treatments in 1965 and 1967.

The Effect of Row Spacing and Plant Population of Corn on Soil Water Depletion

R. J. Cominsky and E. Stallings
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Purpose and Objectives

To determine the effect of 20-, 30-, and 40-inch row spacings with 15,000 and 24,000 corn plants per acre on soil water depletion.

Procedure

Soil water content of the top 42 inches of the soil was measured from June through August in 1965 and 1967. The corn plots were on Chalmers silt loam located at the University of Maryland Plant Research Farm near Beltsville. Moisture measurements were made within steel pipes inserted in each plot with a neutron probe. One-third atmosphere and 15 atmosphere soil moisture percentages were determined in the laboratory on soil samples taken from the entire soil profile from each plot.

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The pattern of moisture depletion was practically the same for all treatments. The maximum removal was from the surface to approximately the 24-inch depth.

Moisture depletion was lower in the early part of the growing season when the plants were small. The soil surface dried out to the point where capillary conductivity beneath the soil surface could not provide adequate water movement to meet evaporation demands.

When rains occurred that did not completely wet the profile, water was depleted simultaneously from regions of high tensions below the wetting front and from areas of low tensions above this front.

Table 1. Average daily meteorological data, average daily soil water depletion, total rainfall, average total soil water depletion, and average total run-off in a corn row spacing and plant population experiment on Chillum silt loam soil in 1965.

Period	Avg.[1] Daily Solar Radiation	Avg. Daily[2] Max. and Min. Temp.	Avg.[2] Daily Dew Pt.	Avg.[2] Open-Pan Evap.	Avg. Daily Soil Water Depletion		Total Rainfall	Avg. Total[4] Soil Water Depletion	Calculated Run-off
					All Days	Non-Rainy Days[3]			
days	langleys/day	°F	°F	in./day	in./day		inches	inches	inches
6/7-6/18	462	78-60	59	0.21	0.11	0.11	0.29	1.19	--
6/18-6/29	495	80-58	59	0.23	0.08	0.06	1.46	0.90	0.70
6/29-7/10	477	85-63	63	0.28	0.09	0.09	0.18	1.01	--
7/10-7/21	424	84-66	68	0.23	0.14	0.16	2.36	1.52	0.64
7/21-8/1	479	84-61	63	0.24	0.12	0.12	--	1.36	--
8/1-8/12	440	85-63	66	0.28	0.14	0.14	2.01	1.54	0.55
8/12/8/23	436	91-63	65	0.23	0.11	0.11	0.16	1.24	--
8/23-9/3	356	82-59	62	0.21	0.14	0.16	2.74	1.58	0.96
Total	--	--	--	1.91	0.93	0.95	9.20	10.34	2.85
Average	446	84-62	63	0.24	0.12	0.12	1.15	1.29	0.36

[1]Measurements taken at University of Maryland Tobacco Farm, Upper Marlboro, Maryland.

[2]Measurements taken at Beltsville, Maryland.

[3]Based on days with no rain or rains less than 0.6 inch. For periods one through eight, the number of non-rainy days was 11, 7, 11, 5, 10, 10, 7, and 6, respectively.

[4]Soil water depletion when rains of more than 0.6 inch occurred between measurements was calculated by adding assumed depletion rate of 0.12 inch per day for each day between meter readings to differences in soil moisture as determined by those readings. When rains of less than 0.6 inch occurred between readings, depletion differences were calculated by adding the rainfall to the differences between the total soil moisture as determined by the readings.

| | | |

Table 2. Average daily meteorological data, average daily soil water depletion, total rainfall, average total soil water depletion, and average total run-off in a corn row spacing and plant population experiment on Chillum silt loam soil in 1967.

Period	Avg.[1] Daily Solar Radiation	Avg. Daily[2] Max. and Min. Temp.	Avg.[2] Daily Dew Pt.	Avg.[2] Open-Pan Evap.	Avg. Daily Soil Water Depletion		Total Rainfall	Avg. Total[4] Soil Water Depletion	Calculated Run-off
					All Days	Non-Rainy Days[3]			
Days	langleys/day	°F	°F	in./day	in./day		inches	inches	inches
6/6-6/17	524	85-57	60	0.22	0.06	0.06	0.05	0.70	---
6/17-6/28	449	85-63	63	0.26	0.06	0.06	1.05	0.70	---
6/28-7/9	395	81-58	61	0.19	0.14	0.16	3.21	1.59	1.41
7/9-7/20	386	84-64	65	0.22	0.14	0.14	1.13	1.49	0.53
7/20-7/31	383	85-65	67	0.24	0.15	0.15	1.16	1.66	0.45
7/31-8/11	410	86-65	70	0.22	0.14	0.15	3.16	1.52	1.97
8/11-8/22	377	82-58	60	0.20	0.13	0.14	2.00	1.42	0.91
8/22-9/2	405	79-60	65	0.17	0.15	0.19	5.51	1.65	2.48
Total	---	---	--	1.72	0.97	1.05	17.27	10.73	7.75
Average	416	83-61	64	0.22	0.12	0.13	2.16	1.34	0.97

[1]Measurements taken at University of Maryland Tobacco Farm, Upper Marlboro, Maryland.

[2]Measurements taken at Beltsville, Maryland.

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| | | |

Table 3. Average total soil water depletion rates for corn plots with 20-, 30-, and 40-inch row spacings and populations of 15,000 and 24,000 plants per acre in 1965 and 1967.

Plant Population	Row Spacing						Average	
	20"		30"		40"			
	1965	1967	1965	1967	1965	1967	1965	1967
	in./day		in./day		in./day		in./day	
15,000 plants per acre	0.121	0.119	0.116	0.120	0.116	0.123	0.118	0.121
24,000 plants per acre	0.119	0.123	0.115	0.124	0.118	0.123	0.117	0.123
Average	0.120	0.121	0.115	0.122	0.117	0.123	0.117	0.122

Table 4. Average soil water depletion during 11-day periods for corn plots with 20-, 30-, and 40-inch row spacings and populations of 15,000 and 24,000 plants per acre in 1965 and 1967.

Period	Row Spacing						Plant Population			
	20"		30"		40"		Low[1]		High[2]	
	1965	1967	1965	1967	1965	1967	1965	1967	1965	1967
	inches		inches		inches		inches		inches	
6/6 - 6/17	1.17	0.73	1.17	0.70	1.24	0.69	1.17	0.69	1.21	0.71
6/17 - 6/28	0.94	0.73	0.92	0.70	0.82	0.69	0.92	0.69	0.88	0.71
6/28 - 7/9	0.98	1.63	1.07	1.53	0.98	1.62	0.97	1.59	1.04	1.59
7/9 - 7/20	1.46	1.51	1.48	1.44	1.60	1.53	1.52	1.48	1.51	1.51
7/20 - 7/31	1.40	1.66	1.36	1.70	1.32	1.63	1.34	1.65	1.38	1.67
7/31 - 8/11	1.54	1.46	1.50	1.48	1.58	1.61	1.50	1.51	1.59	1.52
8/11 - 8/22	1.32	1.40	1.21	1.43	1.19	1.43	1.25	1.40	1.23	1.44
8/22 - 9/2	1.72	1.55	1.47	1.77	1.55	1.64	1.68	1.61	1.48	1.69
Average total per plot	10.53	10.67	10.18	10.75	10.30	10.84	10.35	10.62	10.32	10.84

[1] Low population refers to 15,000 plants per acre.

[2] High population refers to 24,000 plants per acre.

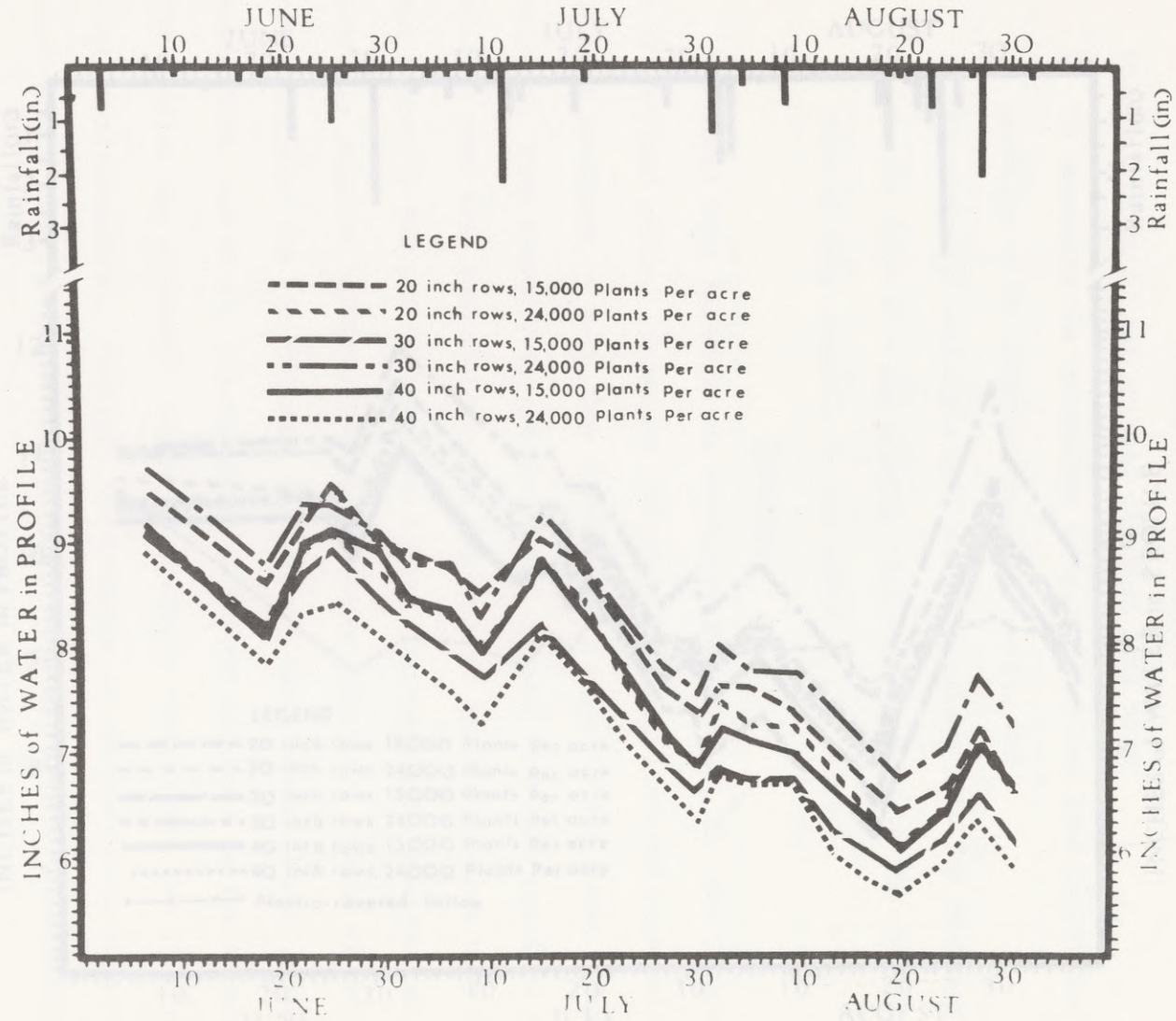

Figure 1 Rainfall and average soil water depletion for three replications of corn in 20-, 30-, and 40-inch rows with 15,000 and 24,000 plants per acre from June 7 to September 2, 1965.

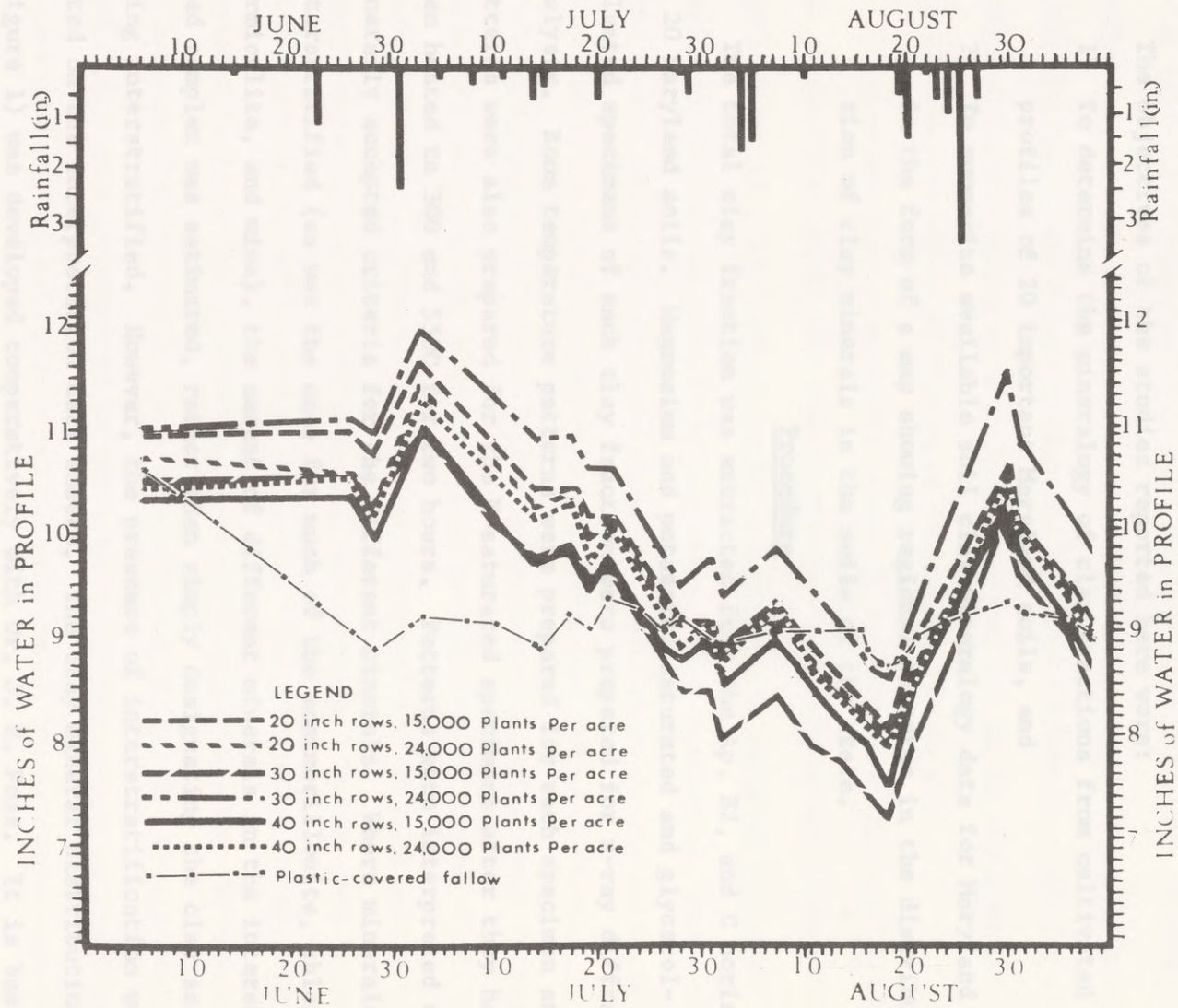

Figure 2 Rainfall and average soil water depletion for three replications of corn in 20-, 30-, and 40-inch rows with 15,000 and 24,000 plants per acre and two replications of plastic-covered fallow plots from June 6 to September 8, 1967.

Clay Mineralogy of Maryland Soils

D. S. Fanning
Department of Agronomy

Purpose and Objectives

The objectives of the studies reported here were:

1) To determine the mineralogy of clay fractions from cultivated profiles of 20 important Maryland soils, and
2) To summarize available soil clay mineralogy data for Maryland in the form of a map showing regional patterns in the distribution of clay minerals in the soils of the state.

Procedure

The total clay fraction was extracted from the Ap, B2, and C horizons of 20 Maryland soils. Magnesium and potassium saturated and glycerol-solvated specimens of each clay fraction were prepared for x-ray diffraction analysis. Room temperature patterns were prepared for each specimen and patterns were also prepared for the K-saturated specimens after they had been heated to 300 and 550C for two hours. Patterns were interpreted using generally accepted criteria for the different minerals. Where minerals were interstratified (as was the case for much of the montmorillonite, chlorite, vermiculite, and mica), the amount of different minerals in the interstratified complex was estimated, rather than simply designating the clay as being interstratified. However, the presence of interstratification was noted on the interpretation data sheets. The clay mineral distribution map (Figure 1) was developed cooperatively with Dr. J. E. Foss. It is based on the distribution of the soil series examined as shown by the general soil map of Maryland.

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Results

Definite regional patterns were found in the distribution of the clay minerals. These patterns are summarized in Figure 1 and are discussed below according to Maryland's 3 main physiographic regions. In addition to the minerals shown in the legend of Figure 1, gibbsite was found in 2 soils (Neshaminy and Chester) from the Piedmont (Table 1). Also, a small amount of quartz occurs in the clay of most of the soils and occasionally a still smaller amount of feldspars is present (Table 1).

Throughout most of Maryland, there is a tendency within soil profiles for an increase in chlorite and in the crystallinity of the clays with approach to the soil surface. This apparently has resulted from acid weathering during the genesis of the soils. This weathering, among other things, has apparently produced aluminous interlayers in the expansible 2:1 layer clays and thus has tended to transform them into chlorite.

Coastal Plain: Except for the Collington soil, only small differences were found in the clay mineralogy between the 10 Coastal Plain soils studied (Table 1). The Collington soil is developed in glauconitic (greensand) sediments and is an extensively occurring soil in the area between Washington, D. C. and Annapolis, Maryland. The clay fraction of this soil contains considerable glauconite, apparently resulting from the breakdown of glauconite pellets that occur in the parent material. Considerable montmorillonite and vermiculite are also found (especially in the B horizons) in the soils developed in glauconitic sediments. They contain less kaolinite and chlorite than the other Coastal Plain soils, however. M. Tapper, for his M.S. thesis, also studied other profiles of the soils developed in glauconitic sediments. His data further support these statements.

The other Coastal Plain soils studied were quite uniform in clay mineralogy. Several different clay minerals were present in these soils, with no one mineral dominating the mineralogical suite (Figure 1). Since the clay mineralogy of the soils of the Coastal Plain is quite uniform, and since most of the reactive minerals in these soils occur in the clay fraction, clay content is a meaningful measurement in this region. It can be used in predicting cation exchange capacity, lime requirement, and other soil properties related to the reactive nature of the clay.

Piedmont: Most of the soils of the Piedmont have developed in residuum from very old igneous and metamorphic rocks. Soils examined from this region included Manor, Mt. Airy, Chester, and Neshaminy. The clay of these soils showed a high degree of weathering, containing more kaolinite than the clay of any of the other soils of the state. Some gibbsite was also detected in the subsoil clay from the Chester and Neshaminy soils (Table 1). Gibbsite indicates a very high degree of weathering.

Even though the Manor and Mt. Airy soils occur on steeper slopes and are considered to be younger soils than the Chester and Neshaminy, their clay fraction contains considerable amounts of highly crystalline kaolinite. Clay from the presumably older Chester soil tended to be less crystalline. The practical significance of these differences in crystallinity is not understood. The clay of the younger soils did contain more mica; thus, these soils may have less need for potassium fertilization -- assuming that some of the potassium in the mica may be released during further weathering.

The Penn soil, which occurs on the red Triassic rocks at the western edge of the Piedmont (in western Montgomery County and extending up through central Frederick County into the northwest corner of Carroll County) was

also studied. The clay fraction of this soil contained less kaolinite than the other Piedmont soils studied. Its clay mineralogy was quite similar to that of the bulk of the Coastal Plain soils except for slightly higher mica contents.

Appalachian Region: Soils examined from this region included the Calvin and Gilpin (developed on red and gray shales, respectively), Hagerstown and Duffield (developed on residuum from limestones) and the Myersville (developed from metabasalt -- in the Middletown Valley). Soils developed from sandstone were not studied.

The soils in the Appalachian region, except for the Myersville, have clay fractions containing more mica than soil clay fractions in other regions. Clays in this region resemble those found in many of the soils in glaciated regions to the north where the parent materials contain shale and limestone. However, more kaolinite is found in the soils of the Maryland mountain region than would be found in most soils of the glaciated regions. The clay of the Maryland soils developed from limestones, shown on the map by a pattern of rectangular blocks, contained more kaolinite than the clay of the soils developed from shales.

The clay mineralogy of the Myersville soil was much different from any of the other soils examined. High contents of the expanding 2:1 layer silicates (vermiculite and montmorillonite) were found. Thus soil clays from this area appeared to be the most reactive of any of those studied. Indirect evidence from other studies (W. R. Wright's M.S. thesis work) indicates that considerable amounts of vermiculite and montmorillonite may also occur in the silt and sand fractions of the Myersville soils. These minerals may result, in the Myersville soils, from the removal during weathering of the brucite sheet of the trioctahedral chlorite, which is a dominant

mineral in the parent material of these soils. Some researchers think that chlorite may be transformed into vermiculite by this mechanism.

Summary

X-ray patterns for clay fractions from AP, B2, and C horizons from 20 important Maryland soil series were prepared and interpreted. Regional patterns in the distribution of soil clay minerals were summarized on a state map.

Within the Coastal Plain the soil-clay mineralogy is quite uniform, except for the soils developed in glauconitic sediments. These clays of the non-glauconitic soils contain a variety of rather poorly crystalline clays that apparently have resulted from acid pedogenic weathering. Clay from glauconitic soils contains glauconite, some montmorillonite and vermiculite, and less kaolinite and chlorite than that from the other Coastal Plain soils. Clays from the Piedmont soils are more kaolinitic than the clays from the other regions. Also, some gibbsite was detected in the "older" soils (Chester and Neshaminy). Clay of soils developed from shales and limestones in the Appalachian region is quite micaceous (or illitic by the terminology of some other workers). Clay fractions contained more kaolinite with the limestone soils than with the shale soils. The Myersville soil, found in the Middletown Valley region, is a unique soil in Maryland for it has clay with high contents of vermiculite and montmorillonite.

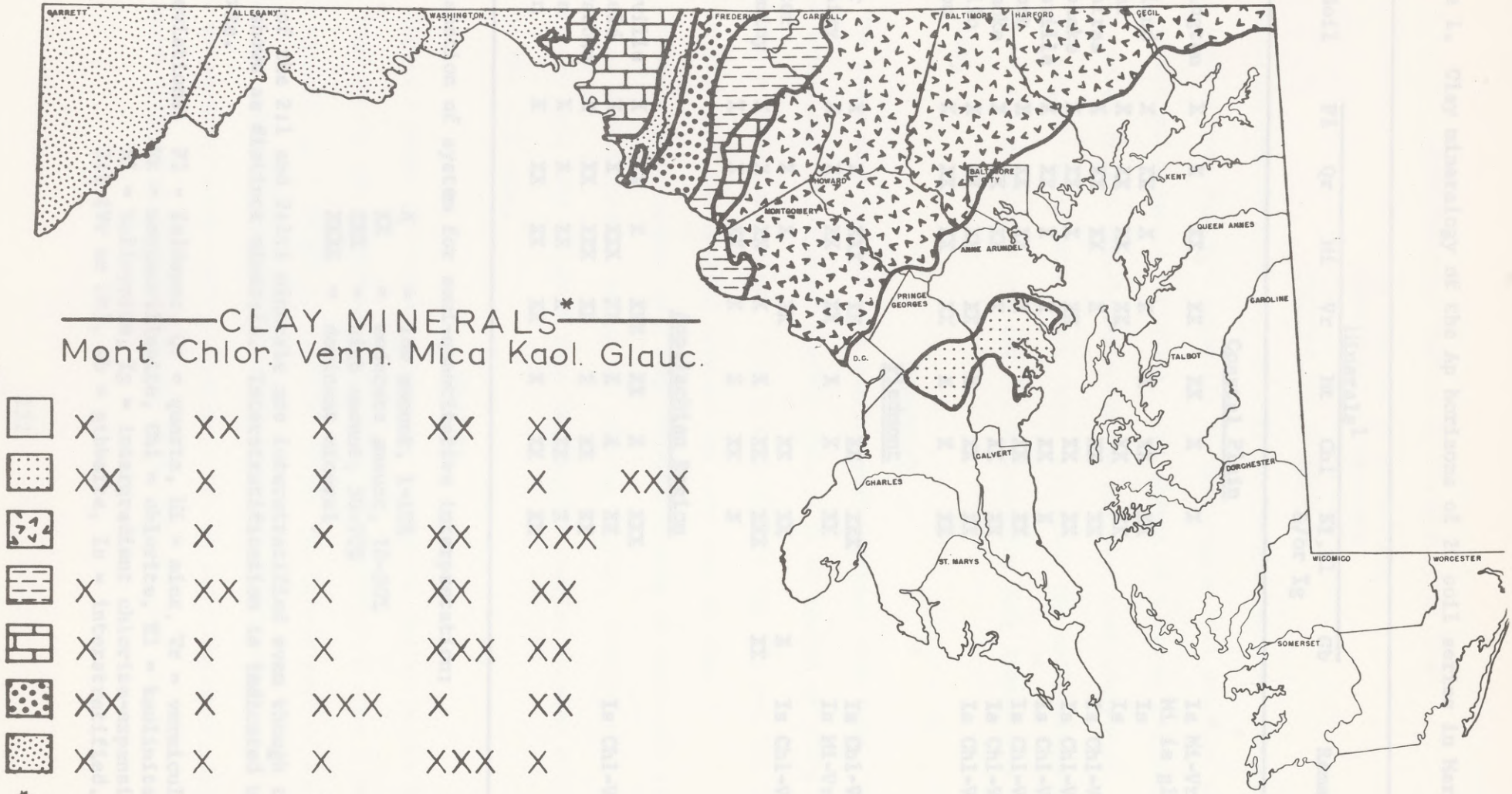

Fig. 1 Distribution of clay minerals in A and B horizons of soils in Maryland (Preliminary study by D.S. Fanning and J.E. Foss, 1968).

Table 1. Clay mineralogy of the Ap horizons of 20 soil series in Maryland.

Soil	Minerals[1]								Remarks
	Fl	Qr	Mi	Vr	Mt	Chl	Kl,Hl &/or Ig	Gb	
Coastal Plain									
Collington	X	X	XX	XX	XX	X	X		Is Mi-Vr-Mt Mi is glauconite
Lakeland	X	XX	X	X	X	XX	XX		Is
Downer	X	XX	XX	XX		XX	XX		Is
Sassafras	X	XX	XX	X		XX	XX		Is Chl-Vr
Matapeake	X	XX	X	XX		XX	XX		Is Chl-Vr
Beltsville	X	XX	X	X		XX	X		Is Chl-Vr
Keyport	X	XX	XX	X		XX	XX		Is Chl-Vr
Pocomoke	X	XX	XX	X		XX	XX		Is Chl-Vr
Othello	X	XX	XX	XX	X	XX	XX		Is Chl-Vr
Elkton	X	XX	XX	XX	X	X	XX		
Piedmont									
Manor	X	X	XXX	XX		XX	XXX		Is Chl-Vr
Mt. Airy	X	X	XX	XX	X	X	XX		Is Mi-Vr-Chl
Chester		X	X	XX		XX	XX	X	Is Chl-Vr
Neshaminy	X	X	XX	X	X	XX	XXX	XX	
Penn	X	X	XX	X	X	XX	X		
Appalachian Region									
Myersville	X	XX	X	XXX	XX	X	XXX		
Duffield	X	X	XXX	XX	X	X	XX		Is Chl-Vr
Hagerstown	X	XX	XXX	XX	X	XX	XX		
Calvin	X	X	XX	X		XX	X		
Gilpin	X	XX	XX	XX	X	XX	XX		

[1]Explanation of system for semi-quantitative interpretation:

X = low amount, 1-10%
XX = moderate amount, 10-30%
XXX = high amount, 30-70%
XXXX = dominant mineral

Many of the 2:1 and 2:1:1 minerals are interstratified even though they have been shown as distinct minerals. Interstratification is indicated under remarks.

Abbreviations: Fl - feldspar, Qr = quartz, Mi = mica, Vr = vermiculite, Mt = montmorillonite, Chl = chlorite, Kl = kaolinite, Hl = halloysite, Ig = intergradient chlorite-expansible 2:1 (Vr or Mt), Gb = gibbsite, Is = interstratified.

Table 1. Clay mineralogy of the Ap horizons of 39 soil series in Maryland.

Soil	Minerals								Remarks
	Pl	Qz	Hl	Vc	Ilt	Chl	Kt,Hl	Gb	
						&/or Ig.			
Coastal Plain									
Collington	X	X	XX	XX	XX	X	X		Ia Hl-Vz-Ilt
									Hl Ia glauconite
Lakeland	X	XX	X	X	X	X	XX		Ia
Downer	X	XX	XX	XX			XX		Ia
Sassafras	X	XX	XX	X			XX		Ia Chl-Vz
Matapeake	X	XX	X	XX			XX		Ia Chl-Vz
Beltsville	X	XX	X	X			XX	X	Ia Chl-Vz
Keyport	X	XX	XX	X			XX	XX	Ia Chl-Vz
Pocomoke	X	XX	XX	X			XX	XX	Ia Chl-Vz
Othello	X	XX	XX	XX	X	XX	XX		Ia Chl-Vz
Elkton	X	XX	XX	XX	X	X	XX		
Piedmont									
Manor	X	X	XXX	XX		XX	XXX		Ia Chl-Vz
Mt. Airy	X	X	XX	XX	X	X	XX		Ia Ilt-Vz-Chl
Chester		X	X	XX		XX	XX	X	Ia Chl-Vz
Neshaminy	X	X	XX	X	X	XX	XXX	XX	
Penn	X	X	XX	X	X	XX	X		
Appalachian Region									
Hyerstville	X	XX	X	XXX	XX	X	XXX		
Buffalo	X	X	XXX	XX	X	X	XX		Ia Chl-Vz
Hagerstown	X	XX	XXX	XX	X	XX	XX		
Calvin	X	X	XX	X		XX	X		
Gilpin	X	XX	XX	XX	X	XX	XX		

Explanation of system for semi-quantitative interpretation:

X = low amount, 1-10%
XX = moderate amount, 10-30%
XXX = high amount, 30-70%
XXXX = dominant mineral

Many of the 2:1 and 2:1:1 minerals are intergradient even though they have been shown as distinct minerals. Intergradient relation is indicated under remarks.

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Soil Moisture Studies on Mattapex Silt Loam

J. E. Foss and E. Strickling
Department of Agronomy

Purpose and Objectives

Moisture studies have been in progress for two years at the Wye Institute. These studies were designed primarily to investigate soil moisture use with plant growth and climatic variables. The effect of a black, polyethylene plastic mulch on corn yields and water use has also been evaluated.

The objectives of this study were: (1) study the soil-moisture status throughout the growing season and (2) evaluate the crop response to a plastic mulch.

Procedure

The plots were located on a nearly level Mattapex silt loam. This soil has a moderately well-drained profile with 32 to 48 inches of silty materials overlying a sandy substratum. Corn was planted on May 10, and the black plastic (1.5 mil) was applied between the corn rows on June 5.

Moisture measurements were made gravimetrically on duplicate plots at one or two week intervals during the growing season. Precipitation and temperature data were obtained from the weather station located within 100 feet of the plot area.

Results

Figure 1 shows the moisture contents at various depths in the Mattapex silt loam during the summer of 1968. Moisture contents on June 5 were near field capacity as a result of rainfall during the latter part of May and during the preceding months (Table 1). Field capacity values of 20.5 and 22.7% moisture by weight were measured on the Ap and B horizons, respectively. Permanent wilting percentages for the same horizons were 5.7 and 7.2%.

Soil Moisture Studies on Mattapex Silt Loam

J. E. Pogs and E. Strickling
Department of Agronomy

Purpose and Objectives

Moisture studies have been in progress for two years at the Wye Institute. These studies were designed primarily to investigate soil moisture use with plant growth and climatic variables. The effect of a black, polyethylene plastic mulch on corn yields and water use has also been evaluated.

The objectives of this study were: (1) study the soil-moisture status throughout the growing season and (2) evaluate the crop response to a plastic mulch.

Procedure

The plots were located on a nearly level Mattapex silt loam. This soil has a moderately well-drained profile with 22 to 40 inches of silty material overlying a sandy substratum. Corn was planted on May 10, and the black plastic (1.5 mil) was applied between the corn rows on June 5.

Moisture measurements were made gravimetrically on duplicate plots at one or two week intervals during the growing season. Precipitation and temperature data were obtained from the weather station located within 100 feet of the plot area.

Results

Figure 1 shows the moisture contents at various depths in the Mattapex silt loam during the summer of 1950. Moisture contents on June 5 were near field capacity as a result of rainfall during the latter part of May and during the preceding months (Table 1). Field capacity values of 20.5 and 22.7% moisture by weight were measured on the Ap and B horizons, respectively. Permanent wilting percentages for the same horizons were 5.7 and 7.2%.

Moisture contents by July 16 showed a 23% loss of total water in the upper 24 inches as compared to values obtained on June 5, and by August 12, approximately 51% of the total water had been extracted from this depth. This is equivalent to 67% of the available moisture in this zone. During the same interval, only 9% of the total water had been lost from the 24 to 36-inch depth, however. These data point out the importance of the upper two feet of soil in supplying water for corn plants in this soil.

The corn yields and plant populations for the conventional and plastic-covered plots are given in Table 2. Although yields were higher for the mulched plots, they were not statistically different. Visual observations during the growing season indicated some beneficial response from the plastic mulch, but the effect was not as pronounced as in the previous year. Warmer temperatures this past year probably explain some of the variation in response to the mulch during these two years.

Summary

A preliminary study of soil moisture in the Mattapex series under corn indicated that water removal was limited primarily to the upper 24 inches of soil. Below this depth water was apparently not used in spite of very dry conditions in the upper 18 inches during July and August. These data are consistent with previous studies on several other soils in Maryland.

On the plastic-covered plots, yields tended to be higher than the conventional plots, but they were not significantly different. The use of a 1.5 mil plastic mulch was unsatisfactory for field plots, as it had a tendency to tear. A 4-mil plastic, or heavier, is preferred for field plot work.

Table 1. Precipitation at the Wye Institute during 1968.

Month	Precip. inches	Deviation from mean	Month	Precip. inches	Deviation from mean
Jan.	2.26	-1.28	July	1.34	-3.51
Feb.	0.61	-2.30	August	2.71	-2.32
March	4.62	+0.72	Sept.	1.45	-2.54
April	1.34	-2.06	Oct.	2.64	-0.41
May	5.29	+1.34	Nov.	3.34	+0.02
June	3.00	-0.52	Dec.	1.77	-1.33

Table 2. Corn yields and stands on conventional and plastic-covered plots at the Wye Institute in 1968.

Treatment	Yield[1] Bu./acre	Coeff. of Var.%	Stand plants/acre
Conventional	121	4.1	19,602
Plastic covered	147	12.5	20,618

[1]Data are means of 3 replications. No significant difference was noted between yields (t-test, 5% level). Significance was obtained at the 10% level, however.

Table 1. Precipitation at the Wye Institute during 1958.

Month	Precip. inches	Deviation from mean	Month	Precip. inches	Deviation from mean
Jan.	2.26	-1.22	July	1.34	-3.51
Feb.	0.61	-2.30	August	2.71	-2.32
March	4.62	+0.72	Sept.	1.45	-2.54
April	1.34	-2.90	Oct.	2.84	-0.61
May	5.25	+1.34	Nov.	3.34	+0.02
June	3.00	-0.52	Dec.	1.77	-1.33

Table 2. Corn yields and stands on conventional and plastic-covered plots at the Wye Institute in 1958.

Treatment	Yield[1] Bu./acre	Coeff. of Var.%	Stand plants/acre
Conventional	131	4.1	19,602
Plastic covered	147	12.5	20,518

[1] Data are means of 3 replications. No significant difference was noted between yields (t-test, 5% level). Significance was obtained at the 10% level, however.

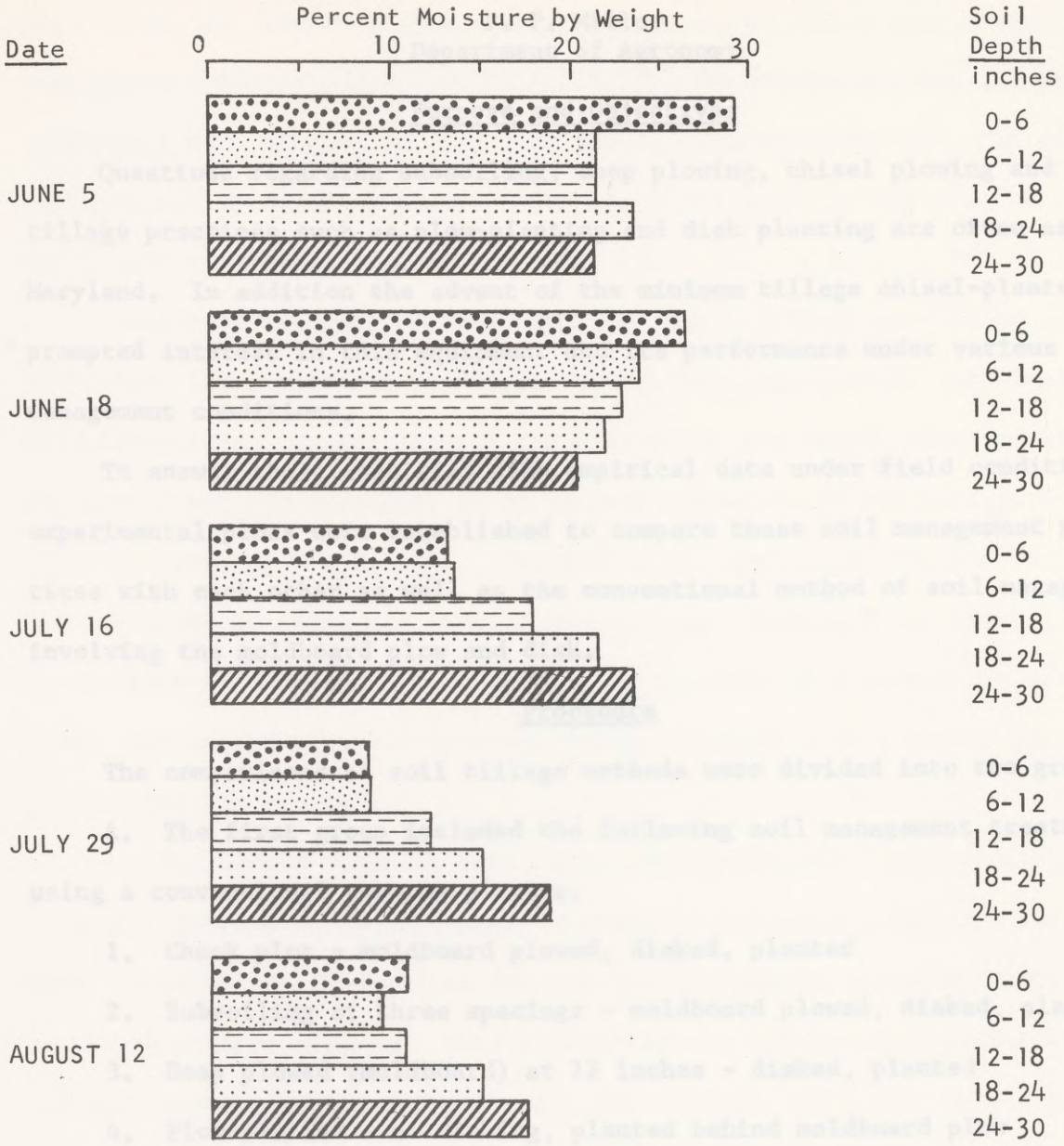

Figure 1 Soil moisture at various depths for the Mattapex silt loam under conventional tillage at the Wye Institute, 1968.

Response of Corn to Various Tillage Practices

F. P. Miller
Department of Agronomy

Purpose and Objectives

Questions regarding subsoiling, deep plowing, chisel plowing and minimum tillage practices such as plow-planting and disk planting are often asked in Maryland. In addition the advent of the minimum tillage chisel-planter has prompted interest in this equipment and its performance under various soil management conditions.

To answer these inquiries with empirical data under field conditions, experimental plots were established to compare these soil management practices with each other as well as the conventional method of soil management involving the moldboard plow and disk.

Procedure

The comparisons of soil tillage methods were divided into two groups.

A. The first group included the following soil management treatments using a conventional two-row planter.

1. Check plot - moldboard plowed, disked, planted
2. Subsoiling at three spacings - moldboard plowed, disked, planted
3. Deep plowed (moldboard) at 12 inches - disked, planted
4. Plow-planted - no disking, planted behind moldboard plow
5. Disk-planted - no plowing, disked twice, planted
6. Chisel plowed to 12 inches - disked, planted

The soils were the Bertie silt loam (somewhat poorly drained) and Mattapex silt loam (moderately well drained). Four replications were used and the plot size was 50 x 20 feet. The corn variety was XL-45 planted May 10 in 30-inch rows.

Subsoiling was done April 18 at a depth of 23 inches and at three spacings of 22, 44, and 80 inches. All plowing, except the chisel plowing and plow-plant operation, was done on April 18. The chisel plowing and plow-plant operations were carried out the same day as planting - May 10. The disk-plant operation involved disking once May 8 and again at the time of planting. Two cultivations were made.

Fertilizer was applied in accordance with soil test results at the rate of 0-80-80 (lbs. per acre of N-P_2O_5- K_2O). This application was broadcast and plowed down. In the case of the disk-plant and chisel plow operations, the fertilizer was broadcast prior to each operation at the rate of 0-80-80 (lbs. per acre of N-P_2O_5-K_2O). Fertilizer was applied in the planter at the rate of 20-40-40 (lbs. per acre of N-P_2O_5-K_2O). Nitrogen was later sidedressed at the rate of 120 pounds N. Atrazine at the rate of 2 pounds per acre was used. Due to the vigorous nutsedge growth, another 1 to 2 pounds per acre of Atrazine was applied.

B. The second group of soil management treatments involved a chisel-planter. Because these treatments involved a different planter, these treatments could not be compared to the previous treatments which utilized a conventional two-row planter. This chisel-planter was designed to cut through residual stover, loosen the soil with its chisels, and plant in one operation. To assess this machine's performance under several soil management conditions, the following treatments were compared:

1. No plowing - chisel planted in unprepared soil
2. Moldboard plowed - chisel planted after soil was moldboard plowed to 8 inches
3. Chisel plowed - chisel-planted after chisel plowed to 12 inches

The soil was a Bertie silt loam. Six replications were used except for the chisel plowed treatment where only 3 reps were possible due to space limitations. Plot size was increased to 24 x 50 feet to accommodate the large equipment. The row width was 36 inches using corn variety XL-45. Planting was done on May 8.

Six replications were planted with the chisel-planter on unprepared soil. Corn stalks had been left from the previous year and the soil was very dry. Six replications were plowed with a moldboard plow and the corn was planted with the chisel-planter. Likewise, three replications were chisel plowed to 10-12 inches and planted with the four row chisel planter. No disking was done. Two cultivations were made on all treatments.

Fertilization involved broadcasting at the rate of 0-80-80 (lbs. per acre of $N-P_2O_5-K_2O$) prior to plowing or planting. It was planned to place an application of 20-40-40 (lbs. per acre $N-P_2O_5-K_2O$) in the row with the planter, but it was possible to place only about half this amount with the adjustments available on the equipment. A side dressing of 120 pounds N per acre as ammonium nitrate was applied later. Atrazine was applied at the rate of 2 pounds per acre with another application of one pound a week later to control the nutsedge.

Results

A. The results from the first group of soil management treatments using a conventional two-row planter are presented in Table 1.

Although the average corn yields vary by as much as 20 bu./acre, statistical analysis indicated that this variation was due to random experimental error, i.e., the differences between treatments were not significant. At the 5% level of significance, a difference of 22 bu./acre was necessary to confirm a significant difference between treatments. Thus, when compared to the con-

ventional method of planting corn (check), none of the treatments were any better or different.

The subsoiling comparison was studied in both 1967 and 1968. In both years no increase in yields over the check were recorded for subsoiling. These data confirm the recommendation that subsoiling does not pay as a soil management practice on most Maryland soils, outside of the possible benefits derived from contour operations. The 20 bu. reduction at the 22-inch spacing may be due to some compaction by the spring subsoiling operation in moist soils. This trend was not consistent, however, with the other spacings.

Likewise, a 20 bu. difference was noted in the plow-plant treatment. Although not statistically significant, elimination of the disking operation probably left a less desirable seedbed. Observations at the time of planting indicated a good seedbed condition except that the soil may not have been compacted enough around each seed.

Deep plowing, chisel plowing and disk-planting did not deviate much from the check plot. Thus, on these soils in this particular year, whether you chisel plowed or eliminated plowing and disked only made little difference when compared with a conventional operation.

B. The results from the second group of soil management treatments using a four-row minimum tillage chisel-planter are presented in Table 2.

Where the soil was tilled either by a moldboard or chisel plow, the chisel-planter responded with respectable yields and no difference existed between the tillage methods. However, planting in untilled soil produced very poor yields (41 bu./acre). At the time of planting, the soil was very dry. As a result, the chisel-planter, despite its weight, was unable to penetrate the soil with its chisels to the designed depth (12-15 inches). Therefore, the trailing planter attachments did not seat properly in the soil

to prepare a good seedbed. It was observed that where the soil was moist, the chisel-planter worked well and a good plant population resulted. Tilling the soil prior to the chisel-planting operation worked the soil enough to allow the chisels to penetrate a little deeper and permit the planting units to seat themselves properly in the soil. Good yields resulted when either a chisel plow or moldboard plow was used prior to the chisel-planter operation. Thus in a dry planting period such as existed in 1968 at the Wye and/or on soils with poor surface structure that form tough crusts, the use of a chisel-planter should be preceded with some tillage implement to loosen the soil. Where good soil moisture and structure conditions exist, the chisel-planter may operate effectively without prior tillage.

Summary

After a two-year trial using corn yield as the criterion, subsoiling is of no value as a soil management practice on most level soils in Maryland. Although there may be soils that might respond to this treatment, rather special conditions must exist before positive responses result as indicated by data from other areas. These conditions are not extensive in Maryland. Deep plowing, chisel plowing and disking only did not differ greatly from the conventional method of preparing land for corn. Plow-planting without disking appeared to be less desirable although not statistically different from the conventional methods.

The success of a chisel-planting operation depends on whether the soil is moist at the time of planting. If dry or hard conditions prevail, it is necessary to till the soil ahead of the chisel-planter. Whether the tillage is through the action of a moldboard or chisel plow makes little difference as indicated in this study.

Table 1. Average corn yields in 1968 from five soil management treatments - Wye Institute.

Treatment	Average Yield bu/acre
Check	118
Subsoiled 22 inches	98
Subsoiled 44 inches	116
Subsoiled 80 inches	105
Deep plowed 12 inches	109
Plow-planted	98
Disk-planted	112
Chisel plowed	107

Table 2. Average corn yields in 1968 comparing a minimum tillage chisel-planter in unplowed, chisel plowed, and moldboard plowed soil - Wye Institute.

Treatment	Average Yield bu/acre
No plowing	41
Chisel plowed	128
Moldboard plowed	120

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Ground Water Table Investigations at the Wye Institute

F. P. Miller and J. E. Foss
Department of Agronomy

Purpose and Objectives

The purpose of this study is to measure the depth and fluctuation pattern of the ground water tables throughout the year in relation to the various soil types and landscape position and to record their response characteristics to precipitation. Data of this type are needed for more accurate interpretation of these and other soils for agricultural and urban uses.

Procedure

Five wells, each four inches in diameter and 8-10 feet deep, were installed on March 8, 1968 in three soil types at the Wye Institute. The wells were cased with non-perforated galvanized down-spouting. Measurements on all wells are made at least once a week when the water tables are above the 8-10 foot level. One well is equipped with an automatic chart recorder which provides a continuous record of the water table position and its pattern of fluctuation.

Water table measurements were made on the following soil types:

Bertie silt loam (somewhat poorly-drained) - 1 well

Mattapex silt loam (moderately well-drained) - 2 wells

Mattapex - Bertie silt loam intergrade - 1 well

Matapeake silt loam (well-drained) - 1 well

A weather station is maintained at the Wye Institute which makes available a daily record of precipitation. Two wells were installed in the Mattapex soil because it is the most extensively occurring soil on the farm.

Results

The position of the water table throughout the year for three soil types is illustrated in Figure 1. Also plotted on this graph is the corresponding daily precipitation. Because the water table in the Matapeake soil was always below 10 feet, it is not recorded on the graph.

The very dry conditions during February are reflected in the relatively low water tables during the first week in March. Subsequent rainfall during March brought the water tables to their highest measured point toward the latter part of the month. During April and May, the water tables continued to fall with very little recharge from precipitation. A total of about 5 inches of rain during late May and early June initiated a rising response of the water table. The water level continued to fall during the summer, fall, and into the winter. The measurable fluctuations were as much as 6 feet and probably more because the water tables at present are beyond the lower limit of the wells.

The relative position of the water tables throughout the period are directly correlated with the drainage class of the soil type. The well-drained Matapeake soil has the lowest water table, the somewhat poorly-drained Bertie soil the highest and the moderately well-drained Mattapex soil has a water table intermediate in position to the Matapeake and Bertie. Thus, the more poorly drained the soil, as determined by morphological characteristics, the higher the water table in relation to the better drained soils. The water table in the well-drained Matapeake soil has never been measurable within the 10 foot well. Even during late March, the water table in this soil was below 10 feet, which suggests that the water level seldom rises above this depth even during the wet spring months.

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The water table correlations with soil drainage classes have been noted throughout the duration of these measurements. These data, along with other ground water observations throughout the State, have shown conclusively that ground water tables and their fluctuation behavior are directly related to the natural drainage class of the soil type. Analysis of these data suggests that the recharge pattern of the water table and the time lag between rainfall and the response of the water level are associated with the landscape position of the soil and its proximity to a local watershed basin where water is only slowly dissipated. Broad areas of uniform soil appear to have water tables which are less susceptible to rapid and strong fluctuations and which respond very slowly to recharge by precipitation. Smaller soil units associated with landscape features where water tends to accumulate have water tables which appear to be governed by the recharge from these water reservoirs.

Summary

Ground water tables measured during 1968 at the Wye Institute in three soil types revealed that the position and fluctuation of the water table was related to the drainage class of the soil and its landscape position. Measurable fluctuations of 6 feet were recorded from a high position in late March to the current water table position in early January, 1969.

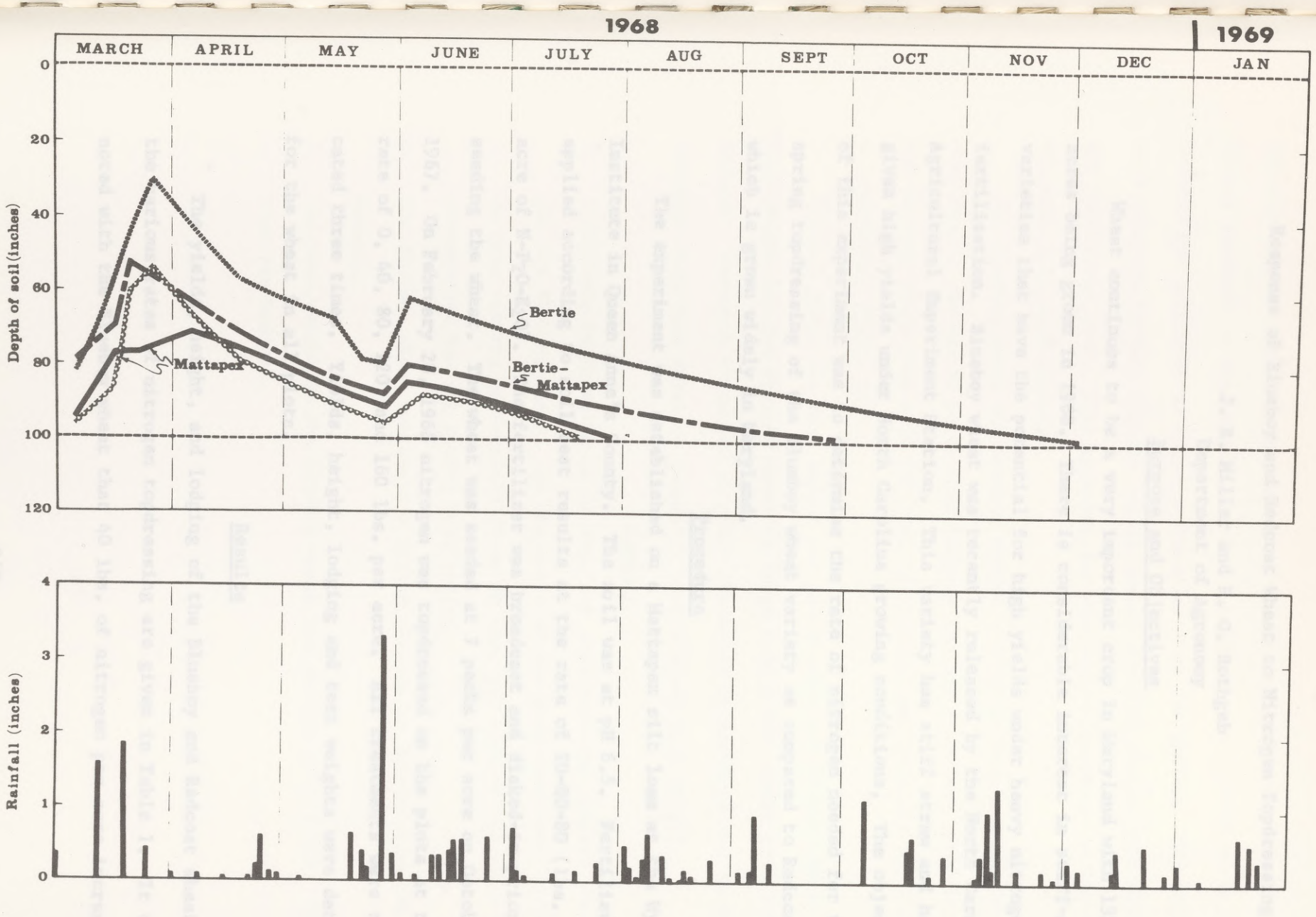
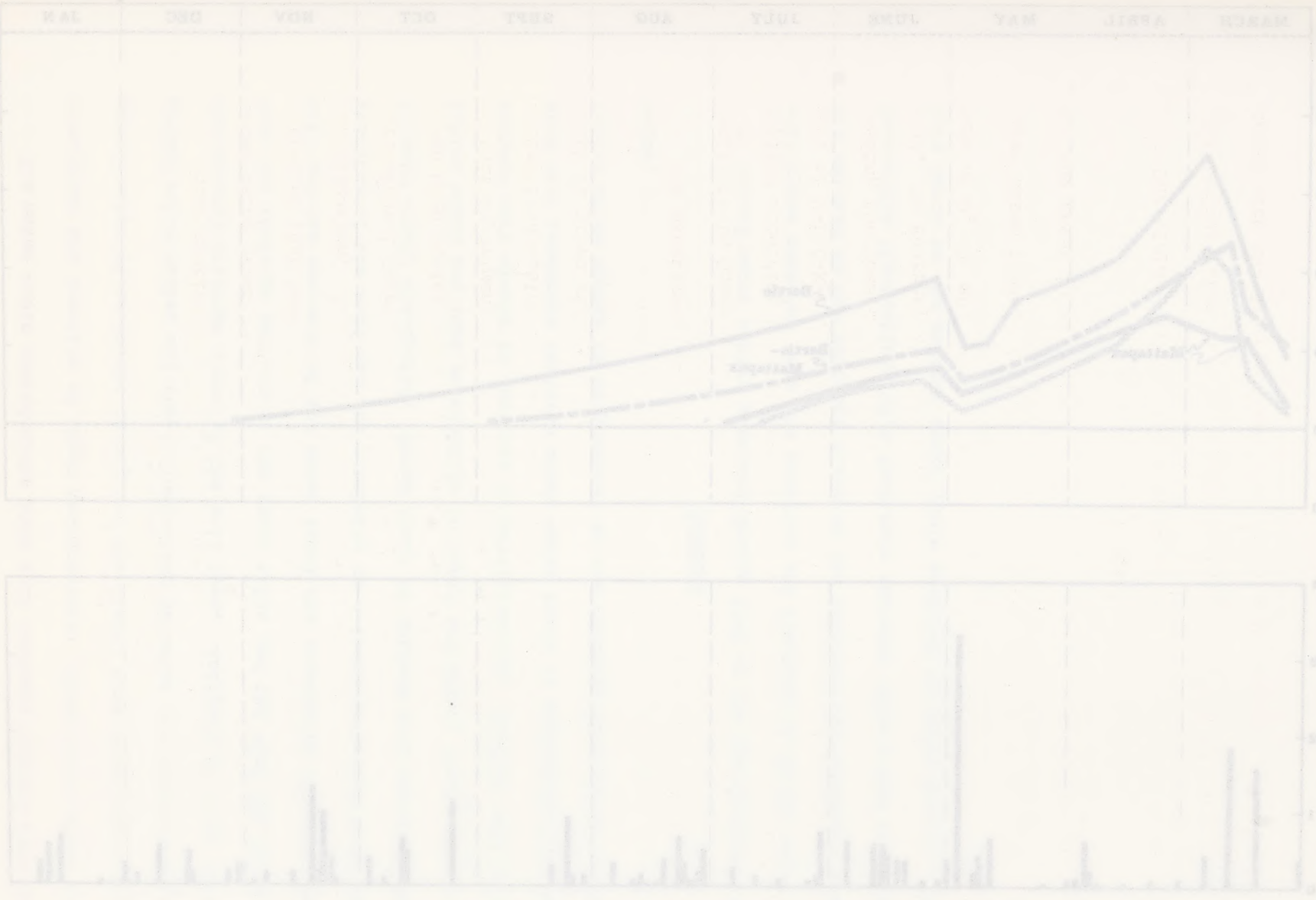


Fig. 1 Water table fluctuations and corresponding precipitation on four sites at the Wye Institute, 1968-69



Response of Blueboy and Redcoat Wheat to Nitrogen Topdressing

J. R. Miller and R. G. Rothgeb
Department of Agronomy

Purpose and Objectives

Wheat continues to be a very important crop in Maryland with 132,000 acres being grown in 1968. There is considerable interest in stiff-straw varieties that have the potential for high yields under heavy nitrogen fertilization. Blueboy wheat was recently released by the North Carolina Agricultural Experiment Station. This variety has stiff straw and has given high yields under North Carolina growing conditions. The objective of this experiment was to determine the rate of nitrogen needed for the spring topdressing of the Blueboy wheat variety as compared to Redcoat which is grown widely in Maryland.

Procedure

The experiment was established on a Mattapex silt loam at the Wye Institute in Queen Anne's County. The soil was at pH 6.5. Fertilizer was applied according to soil test results at the rate of 20-80-80 (lbs. per acre of N-P_2O-K_2O). The fertilizer was broadcast and disked-in prior to seeding the wheat. The wheat was seeded at 7 pecks per acre on October 16, 1967. On February 28, 1968 nitrogen was topdressed on the plots at the rate of 0, 40, 80, 120, and 160 lbs. per acre. All treatments were replicated three times. Yields, height, lodging and test weights were determined for the wheat in all plots.

Results

The yields, height, and lodging of the Blueboy and Redcoat wheat with the various rates of nitrogen topdressing are given in Table 1. It can be noted with the Blueboy wheat that 40 lbs. of nitrogen per acre increased

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Results

The yields, height, and lodging of the Blueboy and Redcoat wheat with the various rates of nitrogen topdressing are given in Table I. It can be noted with the Blueboy wheat that 40 lbs. of nitrogen per acre increased

the yield by 17 bushels. Higher rates of nitrogen did not give any additional increase in the yield. The Redcoat wheat gave a yield of 51.5 bushels per acre with no nitrogen topdressed in the spring. The soil at this location is very fertile and 50 bushel per acre yields with Redcoat are considered good. This accounts for the lack of response to the applied nitrogen with this variety.

The Blueboy wheat was several inches shorter in height than the Redcoat wheat. It can be noted that lodging was not a serious problem with the Blueboy wheat even when 160 lbs. of nitrogen per acre was applied as a topdressing (Table 1).

Table 2 gives the test weight for the Blueboy and Redcoat wheat. The test weight for the Blueboy wheat is about 2 to 3 lbs. lower than for the Redcoat. Research conducted at other locations in Maryland and in North Carolina show this wheat to generally have a lower test weight.

Summary

1. A nitrogen topdressing of 40 lbs. per acre gave the highest yield for the Blueboy wheat. On the basis of the work conducted to date on this variety in Maryland 40 to 80 lbs. per acre of nitrogen is recommended for the spring topdressing.
2. The Blueboy wheat was about 6 inches shorter in height than the Redcoat.
3. The test weight of the Blueboy wheat was usually 2 to 3 lbs. less than the Redcoat.

Table 1. Yield, height, and lodging of Blueboy and Redcoat wheat with several levels of nitrogen topdressing.

Nitrogen Topdressed lb/A	Blueboy			Redcoat		
	Yield bu/A	Height in.	Lodging %	Yield bu/A	Height in.	Lodging %
0	48.2	37	0	51.5	45	0
40	65.5	39	0	51.6	45	0
80	51.4	42	3	52.4	46	8
120	63.4	40	2	53.6	46	5
160	53.8	41	7	47.9	48	10

Table 2. Test weight of Blueboy and Redcoat wheat with several levels of nitrogen topdressing.

Nitrogen Topdressed	Weight per Bushel	
	Blueboy	Redcoat
0	57.0	60.0
40	57.5	60.0
80	59.0	60.0
120	58.0	60.5
160	57.0	60.0

Table 1. Yield, height, and lodging of Bluboy and Redcoat wheat with several levels of nitrogen topdressing.

Nitrogen Topdressed lb/A	Bluboy Yield bu/A	Bluboy Height in.	Bluboy Lodging %	Redcoat Yield bu/A	Redcoat Height in.	Redcoat Lodging %
0	48.2	37	0	31.5	45	0
40	65.5	39	0	51.6	45	0
80	51.4	42	3	52.4	46	8
120	63.4	40	2	53.3	46	5
160	53.8	41	7	47.9	48	10

Table 2. Test weight of Bluboy and Redcoat wheat with several levels of nitrogen topdressing.

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120	58.0	60.5
160	57.0	60.0

Effect of Fall and Spring Plowing on Soil Aggregate Stability and Corn Yield Under Various Cropping Systems

E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the effect of fall and spring plowing on soil moisture, soil aggregate stability, and corn yield under various cropping systems.

Procedure

One-half of each corn plot in a cropping system experiment on Beltsville silt loam is plowed each fall and the remaining half is plowed in in April. This experiment includes long and short rotations as well as continuous corn with a rye-vetch cover crop. Soil samples were taken in July for organic matter and aggregation determination.

Results

The 1967 and 1968 results are presented in Tables 1 and 2. The 1968 fall plowing was delayed until February by frozen ground and wet weather. Table 3 is a summary of the organic matter and soil aggregation data from all plots in each cropping system. No soil moisture measurements were made.

Summary

Fall plowing has had little effect on soil aggregation. If there is an effect, the averages would indicate that it is slightly reduced by fall plowing. Corn yields do not appear to be affected by fall plowing, but were greatly affected by cropping systems. This effect was not due to fertility since all plots received 100 lbs. N., 120 lbs. of P_2O_5 and 120 lbs. of K_2O. An additional 70 lbs. of N was also applied on half of each corn plot. The long term effects of the cropping systems are evident in Table 3. Bare fallow and continuous soybeans with wheat winter cover crop have greatly reduced soil aggregation and soil organic matter while continuous grasses have increased both.

Effect of Fall and Spring Plowing on Soil Aggregate
Stability and Corn Yield Under Various Cropping Systems

E. Strickling
Department of Agronomy

Purpose and Objectives

To determine the effect of fall and spring plowing on soil moisture, soil aggregate stability, and corn yield under various cropping systems.

Procedure

One-half of each corn plot in a cropping system experiment on Belleville silt loam is plowed each fall and the remaining half is plowed in April. This experiment includes long and short rotations as well as continuous corn with a rye-vetch cover crop. Soil samples were taken in July for organic matter and aggregation determination.

Results

The 1957 and 1958 results are presented in Tables 1 and 2. The 1958 fall plowing was delayed until February by frozen ground and wet weather. Table 3 is a summary of the organic matter and soil aggregation data from all plots in each cropping system. No soil moisture measurements were made.

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Fall plowing has had little effect on soil aggregation. If there is an effect, the averages would indicate that it is slightly reduced by fall plowing. Corn yields do not appear to be affected by fall plowing, but were greatly affected by cropping systems. This effect was not due to fertility since all plots received 100 lbs. N, 120 lbs. of P_2O_5 and 120 lbs. of K_2O. An additional 70 lbs. of N was also applied on half of each corn plot. The long term effects of the cropping systems are evident in Table 3. Sods fallow and continuous soybeans with wheat winter cover crop have greatly reduced soil aggregation and soil organic matter while continuous grasses have increased both.

Table 1. Soil aggregation and corn yields on fall and spring plowed plots in a cropping system experiment on Beltsville silt loam.

Cropping System	Aggregation June, 1967		Corn Yield (1967)		Average bu/A
	Fall Plowed %	Spring Plowed %	Fall Plowed bu/A	Spring Plowed bu/A	
Cont. Corn (stalks left Rye vetch cover)	14.5	16.8	139.6	137.3	138.4
Corn, Wheat (stalks left)	18.5	17.9	134.7	133.0	133.8
Corn, Wheat (stalks removed)	12.5	15.5	145.9	144.1	144.9
Sweet Corn, Wheat	15.9	18.2			
Corn, Wheat, Hay	18.3	18.6	153.2	153.7	153.5
Corn, Soybeans, Wheat	13.5	15.2	147.6	144.1	145.8
Corn, Wheat, Hay, Hay	19.2	22.2	165.2	167.1	166.2
Corn, Wheat, 3 years Orchard Grass & Ladino Clover	28.9	29.9	163.0	163.1	163.1
Cont. Soybeans	8.6	7.1			
Soybeans, Wheat, Corn	13.0	15.2			
Cont. Fallow	6.0	5.3			
Average	15.3	16.5	149.8	148.9	149.4

Table 1. Soil aggregation and corn yields on fall and spring plowed plots in a cropping system experiment on Belleville silty loam.

Cropping System	Aggregation June, 1957	Corn Yield (1957)		
	Fall Plowed	Spring Plowed	Fall Plowed	Spring Plowed	Average
	%	%	bu/A	bu/A	bu/A
Cont. Corn (stalks left Rye vetch cover)	14.5	15.9	139.6	137.3	138.4
Corn, Wheat (stalks left)	18.5	17.5	134.7	133.0	133.8
Corn, Wheat (stalks removed)	12.5	15.5	145.9	140.1	144.0
Sweet Corn, Wheat	15.9	18.2			
Corn, Wheat, Hay	18.3	16.6	153.2	153.7	153.5
Corn, Soybeans, Wheat	13.5	15.2	147.6	144.1	145.8
Corn, Wheat, Hay, Hay	19.2	22.2	165.2	157.1	161.2
Corn, Wheat, 3 years Orchard Grass & Ladino Clover	28.9	25.5	163.0	163.1	163.1
Cont. Soybeans	8.6	7.1			
Soybeans, Wheat, Corn	13.0	15.3			
Cont. Fallow	6.0	5.3			
Average	15.3	15.3	149.8	146.9	148.4

Table 2. Soil aggregation and corn yields on fall and spring plowed plots in a cropping system experiment on Beltsville silt loam.

Cropping System	Aggregation June, 1968		Corn Yield (1968)		
	Fall Plowed %	Spring Plowed %	Fall Plowed bu/A	Spring Plowed bu/A	Average bu/A
Cont. Corn (stalks left Rye vetch cover	11.4	12.2	33.9	28.0	31.0
Corn, Wheat (stalks left)	15.0	16.1	37.9	48.3	43.1
Corn, Wheat (stalks removed)	10.4	14.2	41.0	30.5	35.8
Sweet Corn, Wheat	11.8	12.8			
Corn, Wheat, Hay	15.7	16.2	63.3	53.6	58.4
Corn, Soybeans, Wheat	14.8	15.0	47.7	45.7	46.7
Corn, Wheat, Hay, Hay	19.9	20.6	74.0	69.4	71.7
Corn, Wheat, 3 years Orchard Grass & Ladino Clover	27.4	31.2	61.2	57.3	59.3
Cont. Soybeans	5.0	4.7			
Soybeans, Wheat, Corn	10.0	10.0			
Cont. Fallow	4.0	3.8			
Average	13.2	14.3	51.2	47.6	49.4

Table 5. Soil aggregation and corn yields in fall and spring plowed plots in a cropping system experiment on Baltaville silt loam.

Cropping System	Aggregation June, 1958		Corn Yield (1958)		
	Fall Plowed	Spring Plowed	Fall Plowed	Spring Plowed	Average
	%		bu/A	bu/A	bu/A
Cont. Corn (stalks left Rye vetch cover	11.4	12.2	33.9	28.0	31.0
Corn, Wheat (stalks left)	15.0	16.1	37.9	48.3	43.1
Corn, Wheat (stalks removed)	10.4	16.2	41.0	30.2	35.6
Sweet Corn, Wheat	11.8	12.8			
Corn, Wheat, Hay	15.7	16.2	63.3	33.6	50.4
Corn, Soybeans, Wheat	14.8	15.0	47.7	45.7	46.7
Corn, Wheat, Hay, Hay	19.9	20.6	74.0	69.4	71.7
Corn, Wheat, 3 years Orchard Grass & Ladino Clover	27.4	31.2	61.2	57.3	59.3
Cont. Soybeans	5.0	4.7			
Soybeans, Wheat, Corn	10.0	10.0			
Cont. Fallow	4.0	3.8			
Average	13.2	14.3	51.2	47.6	49.4

Table 3. Soil organic matter and aggregation of plots in a cropping system experiment on Beltsville silt loam.

Cropping System	Soil Organic Matter		Soil Aggregation	
	1952	1968	1952	1968
Cont. Corn	1.57	1.52	17.0	11.8
Cont. Wheat	1.63	1.67	24.1	22.4
Cont. Soybeans	1.74	1.21	19.9	4.9
Cont. Bare Fallow	1.52	0.75	19.4	3.9
Cont. Bluegrass	1.56	1.68	23.6	45.6
Cont. Orchard Grass, Ladino Clover	1.60	1.79	21.1	45.0
Corn, Wheat (stalks left)	1.53	1.66	19.5	15.8
Corn, Wheat (stalks removed)	1.64	1.52	19.8	12.7
Sweet Corn, Wheat	1.58	1.54	21.4	13.0
Corn, Wheat, Hay	1.56	1.57	19.7	15.4
Corn, Soybeans, Wheat	1.60	1.55	19.4	13.0
Corn, Wheat, Hay, Hay	1.63	1.73	22.1	19.0
Corn, Wheat, Pasture, Pasture, Pasture	1.59	1.68	20.7	28.5

Table 3. Soil organic matter and aggregation of plots in a cropping system experiment on Bolivar silt loam.

Cropping System	Soil Organic Matter 1952	Soil Organic Matter 1956	Soil Aggregation 1952	Soil Aggregation 1962
Cont. Corn	1.57	1.52	17.0	11.8
Cont. Wheat	1.63	1.67	24.1	22.4
Cont. Soybeans	1.74	1.71	19.5	4.3
Cont. Bare Fallow	1.52	0.75	19.4	3.3
Cont. Bluegrass	1.56	1.68	23.5	45.5
Cont. Orchard Grass, Ladino Clover	1.60	1.75	21.1	45.0
Corn, Wheat (stalks left)	1.53	1.66	19.5	15.8
Corn, Wheat (stalks removed)	1.64	1.52	19.3	12.7
Sweet Corn, Wheat	1.58	1.54	21.4	13.0
Corn, Wheat, Hay	1.56	1.57	19.7	15.4
Corn, Soybeans, Wheat	1.60	1.55	19.4	13.0
Corn, Wheat, Hay, Hay	1.63	1.73	22.1	42.0
Corn, Wheat, Pasture, Pasture, Pasture	1.59	1.68	20.7	35.9

The Cation-Exchange Capacity of Twenty Maryland Soils

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Department of Agronomy

Purpose and Objectives

Although 97% of the detailed soil survey in Maryland has been completed, more analytical data on the more than 200 soil series are required. Information on basic characteristics of soils, such as cation-exchange, is required for the greater scope and refinement of interpretations associated with mapping units in Maryland.

The objectives of this study were: (1) study the cation-exchange capacity of the Ap, B2, and C horizons of twenty important agricultural soils in Maryland and (2) investigate the association of this property with the percent clay and organic matter in the respective horizons. This investigation is part of a larger soil-characterization study carried out in the Department of Agronomy to lend support to the Cooperative Soil Survey.

Procedure

Twenty soil series were selected for this study, and three modal profiles of each series were described and sampled according to standard procedures. These series are representative of major agricultural soils, parent materials, and textural groupings found in Maryland.

Samples were air-dried in the laboratory, crushed with a wooden rolling pin, and passed through a 10-mesh sieve. All subsequent analyses were run on the less-than 2-mm material. The cation-exchange capacity was determined by a method proposed by Chapman[1], with minor modifications. Exchangeable acidity was determined by the barium chloride-triethanolamine method, and exchangeable cations (Ca, Mg, K, and Na) were determined on the atomic

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[1] Chapman, H. D. 1965. In C. A. Black (ed.) Methods of Soil Analysis, part 2, Agronomy Monograph. 9:891-901.

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W. R. Wright and J. E. Rose
Department of Agronomy

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absorption spectrophotometer. Organic matter was determined by the Walkley-Black method, and the pipette method was used for particle-size determinations.

Results

Table 1 shows the average cation-exchange capacity of the Ap, B2, and C horizons of the soils studied. A great deal of variation exists in the CEC of soils in Maryland. For example, Lakeland soils have CEC values of 1 to 3 meq/100g while Myersville soils show values of 25 to 37 meq/100g. Variability of CEC is generally explained by observing the percent clay and organic matter and the type of clay minerals in each series.

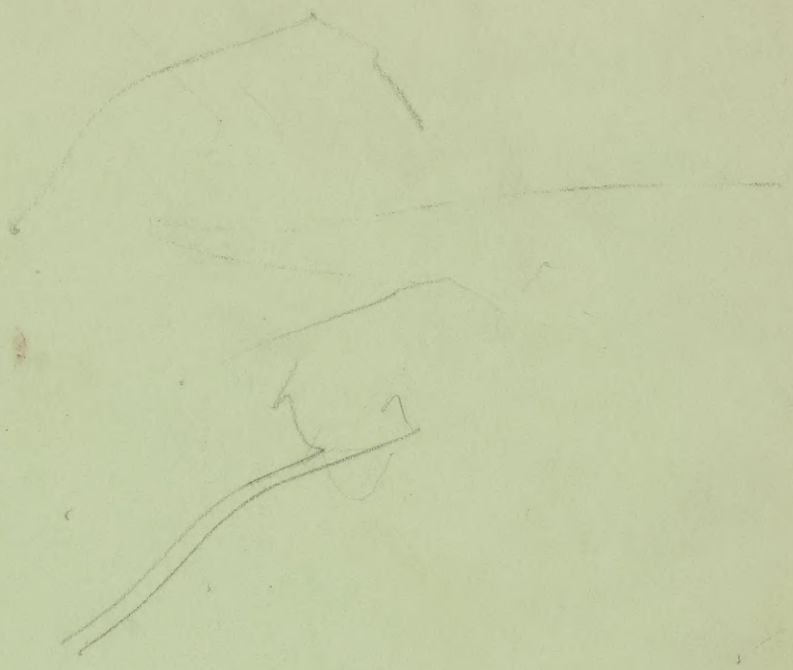
In general, the CEC is higher in those soils with finer textures. This can be noted in the Keyport and Elkton series in the Coastal Plain. Coarse-textured soils such as Lakeland and Downer, on the other hand, show low values of CEC primarily as a result of the low content of clay. A correlation coefficient of r=0.71 (significant at the 1% level) was obtained from CEC and percent clay for all samples in this study.

The organic matter also influences the CEC, and the Pocomoke series shows this most dramatically. The average CEC value of 41.4 meq/100g in the Ap horizon represents an average organic matter content of 22.6%. This value is 10 times the average organic matter content of Ap horizons in all other soils in this study. The higher CEC values of the Ap horizons in the Appalachian and Piedmont also reflect higher organic matter contents as compared to the Coastal Plain soils. The average organic matter content in the Ap horizons of the Coastal Plain, Piedmont, and Appalachian provinces are 1.6, 2.4, and 3.1, respectively. The value for the Coastal Plain does not include the Pocomoke series as this soil is vastly different from others selected.

Variations in CEC resulting from the influence of clay mineralogy are evident in several soils in this study. The Myersville soils, for example, had an average of 15.8 and 9.0% clay in the B and C horizons, respectively. However, this soil had CEC values of 37 meq/100g. The high CEC values are partially the result of vermiculite clays dominating in these soils, as contrasted to other soils in Maryland. Also, the Hagerstown soils with 59.8 and 50.7% clay in the B and C horizons, respectively, show average CEC values of 17.4 and 14.9 meq/100g in these same horizons. The high content of kaolinite type of clay mineral is probably reflected in these low CEC values.

Summary

Sixty modal profiles representing 20 soil series from the three physiographic provinces of Maryland were described and sampled. The variation in CEC values of the twenty soils could generally be explained by examining their texture, organic matter, or clay mineralogy. Soils of the Coastal Plain exhibited higher correlations between clay and organic matter than soils from the other two provinces; about 92% of the variation in CEC of the Ap horizons could be explained by the clay and organic matter. The variables influencing CEC in soils from the Piedmont and Appalachian regions are more complex, however. In order to accurately predict CEC on these soils, it is necessary to study more than clay, organic matter, and mineralogy. The dispersion method for particle-size analysis, presence of iron oxides, exchange capacity of silts, or possibly other unknown factors are contributing to the apparent lack of correlation with the usual variables of CEC.

Table 1. The average cation-exchange capacity (by summation of cations) of the Ap, B2, and C horizons of twenty soil series in Maryland.

Soil Type	Cation Exchange Capacity meq/100g		
	Ap horizon	B horizon	C horizon
	- Coastal Plain -		
Beltsville silt loam	10.8	12.8	17.1
Collington loamy sand	9.4	19.1	15.9
Downer loamy sand	6.2	7.6	2.9
Elkton silt loam	12.3	17.3	16.6
Keyport silt loam	12.6	20.8	14.9
Lakeland sand	3.2	--	1.1
Matapeake silt loam	11.1	12.6	6.9
Othello silt loam	10.7	13.7	4.9
Pocomoke sandy loam	41.4	16.7	1.9
Sassafras sandy loam	6.0	9.3	2.3
	- Piedmont -		
Chester silt loam	15.0	12.2	11.5
Manor loam	13.5	9.8	5.2
Mt. Airy loam	17.7	9.4	8.2
Neshaminy silt loam	14.9	16.0	9.2
Penn silt loam	14.8	15.2	16.6
	- Appalachian -		
Calvin loam	15.9	14.1	--
Duffield silt loam	14.7	12.1	11.0
Gilpin silt loam	23.3	13.0	11.9
Hagerstown silt loam	13.5	17.4	14.9
Myersville silt loam	25.4	37.1	37.9